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MAFF To Begin "DNA Bank" Database Project

94FE0765A Tokyo NIHON NOGYO SHIMBUN in Japanese 5 May 94 p 7

[Text] The "DNA Bank Project", which the Ministry of Agriculture, Forestry, and Fishery (MAFF) will start during the 1994 fiscal year, is the so-called "gene publication" of the "MAFF Gene Bank Project" that is already in existence. In the international competition in biotechnology research and development, which gets more intense with each passing year, there is great expectation that the "DNA Bank" will be a powerful resource.

With rapid advances in biotechnology research, there is a growing expectation that technologies such as gene recombination will lead to breakthroughs in developing new types of plants and animals.

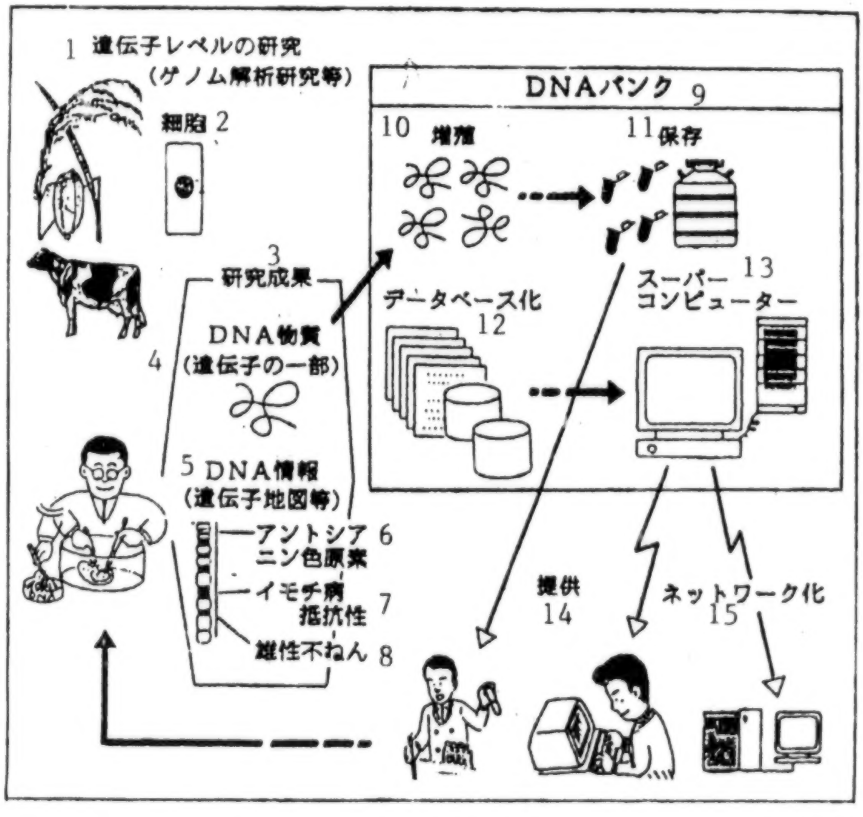
In order to effectively promote this research, it is indispensible that appropriate ways be found to manage the research results that have recently been accumulating at an accelerating pace, and to create an infrastructure for utilizing those results.

The aim of the DNA Bank Project is to systematically collect, organize, and disseminate the DNA material itself (i.e., portions of genes) from crops and livestock, which represents the results of research at the gene level, as well as other DNA-related information, such as gene maps. (See the figure.)

With regard to managing and disseminating DNA-related information, the plan is to use a supercomputer to implement the main "DNA Information Management and Use System", a database to store information such as gene maps for organisms such as crops and livestock, as well as references to the literature. Since research organizations will be able to use this database, it provides an infrastructure for indexing the existing information.

The Agricultural Biological Resources Laboratory within MAFF is responsible for this project. It is located in Tsukuba City, Ibaraki Prefecture.

For ten years, the MAFF Gene Bank Project has been supporting experimental work in a variety of leading edge technologies, including biotechnology. It divides its goals into five areas: plants, animals, microorganisms,



Key: 1. research at the gene level (such as genome analysis); 2. cell; 3. research results; 4. DNA material (portions of genes); 5. DNA-related information (such as gene maps); 6. anthocyanin chromogen; 7. rice blight resistance; 8. male sterility; 9. DNA Bank; 10. reproduction; 11. preservation; 12. database creation; 13. supercomputer; 14. dissemination; 15. network creation.

forests, and aquatic organisms, cooperating with universities and private industry to gather and preserve genetic resources and related information, both within Japan and internationally.

The new DNA Bank will be the sixth element within MAFF's Gene Bank, according to the executive office of MAFF. Thus, it will make the future work of the Gene Bank more complete.

NEDO Introduces New Chromatography Using Temperature-Sensitive Polymer

94FE0765B Tokyo NIKKAN KOGYO SHIMBUN in Japanese 2 May 94 p 7

[Text] Chromatography is a fundamental method known to everyone in the fields of chemistry and biology. An organic solvent is passed through beads or some other filling material which has already absorbed a certain mixture, and the properties of the solvent are used to separate or purify the mixture. A new, alternative idea is to vary the properties of the filling material to perform the separation. Using a functional polymer whose hydrophilic nature changes with temperature to perform a separation or purification allows water to be used as the solvent, thus making it possible to separate substances such as enzymes or cells that are not stable in organic solvents. Practical applications are expected soon, such as to increase the recovery efficiency of physiologically active substances used in the manufacture of pharmaceuticals.

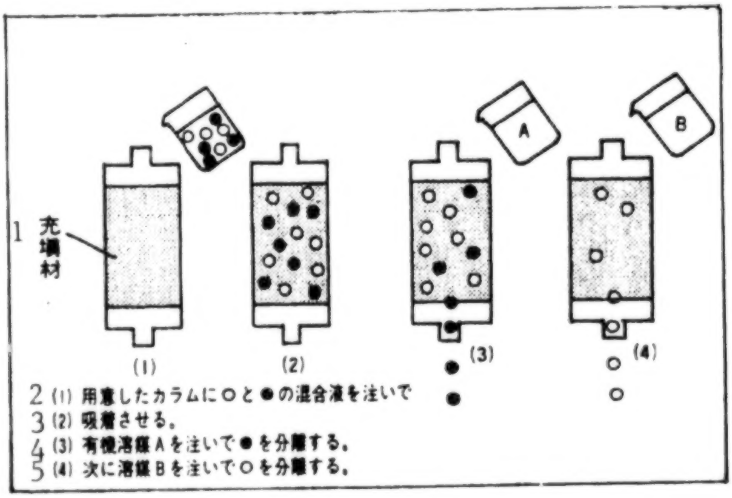
Separation or purification by the method of chromatography is usually performed by using a filled column. A liquid mixture is poured in the top, followed by an organic solvent where one of its properties is gradually changing, such as its polarity. This causes the components of the mixture to separate and flow out the bottom, and the sequence in which the components appear depends on how the solvent changes.

In other words, the main idea behind the separation concerns the balance between the affinities of the components for the solvent, versus their affinities for the filling material. So, rather than varying the properties of the solvent, what about varying the properties of the filling material? The purpose of this is to avoid using an organic solvent for the separation. That is, many substances used in biological research, such as physiologically active substances, cells, and genes, are generally unstable in organic solvents, or such solvents may reduce the activity of enzymes.

These ideas saw fruition in a project that was completed in March, titled "Investigation Concerning the Development of New Methods For Separation and Purification Using Aqueous Systems", funded by the New Energy Industrial Technology Joint Development Organization (NEDO). This organization is a combination of government, industry, and academia, including filling material manufacturers such as Toso and large-scale users of blood cell separation methods such as the Japan Red Cross. The intention is to become a project sponsored by the Ministry of International Trade and Industry (MITI).

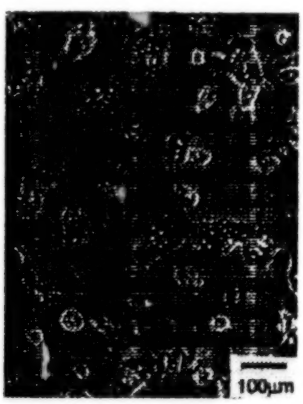
Other participants in the investigation include Chisso, Mitsubishi Chemical, Asahi Medical, Nihon Yushi, and Telmo. The chairman of the investigation committee, Professor Mitsuo Okano of the Tokyo Women's Medical College, emphasized the freshness of this new idea in the following way: "Up until now, when one spoke about functional materials, one meant a single material that was given a certain collection of properties. But for the new filling material, the point is to be able to vary its properties."

Concepts of Traditional Chromatography

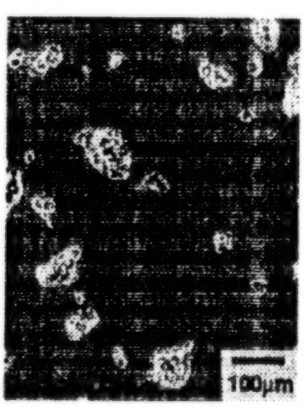


Key: 1. filling material; 2. pour the mixture into a prepared column; 3. let it be absorbed; 4. pour in solvent A to separate out one component; 5. pour in solvent B to separate out the other component

More specifically, the new material is a polymer of isopropyl acrylamide that varies between being hydrophilic and hydrophobic at about 32°C. Professor Okano, working with Professor Yasuhisa Sakurai and others at the Tokyo Women's Medical College, grew cells on this polymer, lowered the temperature so that the polymer changed from being hydrophobic to being hydrophilic, and saw that the cells naturally separated from the polymer, thus developing a new recovery method. Liver cells separated more readily than rat fibroblast cells, so it was demonstrated that the method can be used to separate different types of cells.



Cells are grown on a temperature sensitive polymer, clinging to the polymer as they grow.



Five minutes after changing the temperature the cells become spherical and separate from the polymer.

The first step has also been taken in conferring this property upon a filling material. In cooperation with Professor Yoshikazu Matsushima of the Joint College of Pharmacy, this polymer was combined with silica gel, a common filling material. The affinity for non-polar compounds was seen to vary with the temperature, making it possible to separate substances that were difficult to separate in the past.

Susumu Banno, head of the Measurement Research Department at the Japan Red Cross Blood Plasma Separation Center, commented on the hopes for future applications: "This may become an important rival of affinity chromatography, a leading-edge technology in the biological field. Affinity chromatography uses antibodies produced from mice, but the new method [developed by the group led by Professor Okano] only relies on industrial compounds, and therefore we will not have to worry about impurities."

Although the new method has promise for many types of cell separations, it may be especially useful for separating out stem cells for bone marrow transplants. A major factor discouraging blood plasma transplants is that they also represent major surgery for the donor. However, the same stem cells that exist in bone marrow are also found in small capillaries, and if an efficient method of separating these cells could be found, then they could be used instead. An operation would no longer be necessary if the stem cells needed for the transplant could be obtained from a simple blood draw.

The range of applications would become much larger if it were also possible to separate physiologically active substances such as the interferon produced by genetic engineering. With the usual methods of chromatography, the recovery efficiency is low even after repeated separations and purifications. The new method should be able to improve this, performing the separation in a single column whose properties can be changed. Another point encouraging commercialization is that the new method only requires water, thus avoiding the expense of using organic solvents.

Tokyo Institute of Technology Develops Continuous Composition Method for Sugar Chain

94FE0765C Tokyo NIKKAN KOGYO SHIMBUN in Japanese 13 May 94 p 5

[Text] Assistant Professor Koji Takahashi and Instructor Haruo Yamada of the Engineering Department at the Tokyo Institute of Technology have developed a continuous synthesis method for sugar chains. The sugar chains are grown in a single reaction vessel by sequentially adding a sugar that contains an active radical and then an activating agent. Usually, reactivity tends to go down as a chain becomes longer, but the new synthesis method does not show that tendency. Also, there are few side products, which should allow the development of automatic synthesis equipment. Sugar chains are under consideration for developing pharmaceuticals against cancer metastatis and viral infections. The lack of a simple mass-production synthesis method has blocked research in this area, so the new method should be a great help to sugar chain engineering.

A problem in sugar chain research has been the lack of automatic synthesis equipment such as is commonly used for proteins and DNA. In order to screen the useful oligo sugars and use them in animal experiments, mass

production synthesis is required, and a chemical reaction has been sought that can be automated. However, sugars are complicated, and their synthesis usually creates many side products. In order to create a chain of a single type of sugar it may be necessary to use a variety of guard radicals and a reaction with as many as seven stages.

The new synthesis method developed by the group led by Assistant Professor Takahashi sequentially adds a first sugar and then a second sugar to the original sugar chain. First, an active radical A is added to the end of the sugar chain. Then, an activating agent α is selected to combine with this radical, and it is also reacted with the first sugar. After this, another active radical B is added to the first sugar. Since the newly constructed sugar chain now contains B, a different activating agent β is selected and reacted with the second sugar. This process is repeated to grow the sugar chain.

So far the method has been used to synthesize oligosaccharine, which is used for anti-bacterial agents in plants. A basic structure consisting of six sugars has been effectively synthesized.

The new method uses the combination of an active radical and an activating agent (for example, the phenylthio radical and trifluroroacetic acid) to control the reaction and reduce side products, allowing the reaction to be iterated in a single vessel without having to separate out the product. There was a previous method that combined the sugar chain with a polymer in a sequential reaction, but the reaction vessel had to be changed after the addition of each sugar, making automation difficult.

Sugar chains are used to transmit information between one cell and another cell, enzyme, or bacterium. Research is actively trying to clarify the mechanism by which sugar chains are used for this purpose, and to develop pharmaceuticals.

For example, sugar chains are believed to be involved in cancer metastasis, and it is hoped that agents to control metastasis could be developed if the sugar chain involved in this was clearly established.

Asahi Breweries Develops Allergen Using Gene Recombination

94FE0765D Tokyo NIKKEI SANGYO SHIMBUN in Japanese 16 May 94 p 5

[Text] Asahi Beer's main laboratories have succeeded in using gene recombination technology to produce allergens in a highly pure form. Allergens are the substances that cause allergies, such as atopic disease. It is known that giving a small amount of allergen to a patient can alleviate the allergic reaction, and it is said that gene recombination in the future will make it possible to produce allergens as both diagnostic and curative agents. Allergens exist in very small quantities in nature, and extracting them is difficult. The experiments were performed in cooperation with Nikka Whiskey, Torii Pharmaceuticals, and Tokyo University.

The allergen for atopic disease is a protein produced by Dermatophagoides farinae ("Derfi"), one type of tick found in household dust. The research group removed from these ticks the gene for producing the Derfi protein and inserted it into the cells of another kind of insect in order to synthesize the same protein artificially. They obtained from 20 to 30 milligrams of the Derfi protein from one liter of cell culture.

Within the body, the allergen combines with the antibody named immunoglobin E (IgE) to cause the allergic reaction, and the artifically produced Derfi protein has the same reaction with human IgE as the natural protein. There had been general methods for extracting the protein from ticks in the past, but the methods of genetic engineering are more efficient and produce a purer product. In order to completely cure an allergy, an allergen is gradually administered to a patient in order to alleviate the allergic response ("diminished sensitivity treatment"). Yasushi Okumura, head of the Molecular Biology Research Department in the Asahi laboratories, expects that "the Derfi protein produced by gene recombination can be used for this type of treatment".

Kazusa DNA Research Institute Announces Research Themes

94FE0765E Tokyo NIKKEI SANGYO SHIMBUN in Japanese 16 May 94 p 5

[Text] The research program for the Kazusa DNA Research Institute has been decided. The institute is opening in October in Kisarazu City, Chiba Prefecture, with Sotoshi Hiraiwa, consultant to Tokyo Electric Power, as the chairman. It will specialize in DNA (deoxyribonucleic acid) research, and initially the main research themes of the institute will be the analysis of the DNA of blue-green algae and the analysis of human gene structure. The institute will be interested in all forms of DNA research, from basic research into gene structure and function to the development of analysis techniques.

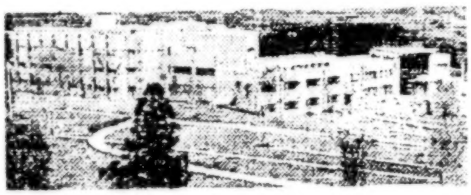
The institute will begin with five research laboratories and one structure and analysis laboratory, and plans to add two gene function laboratories in the near future. In the area of gene structure, they will analyze the complete structure of blue-green algae DNA, of which there are from three to four million types. They will investigate the mechanisms of photosynthesis and conduct research related to the development of biotechnologies for preventing global warming. They will also promote the analysis of human gene structure, which will be beneficial to the understanding of diseases that are genetic in origin.

The institute will also promote communication among researchers both within and outside of Japan. The institute will set up the various laboratories, invite consultants to the laboratories, help set up common research floors

within the laboratories, and be a focal point for research in cooperation with universities and the private sector.

The institute will be at the center of Kazusa Academic Park, an academic research center whose facilities are being built in Chiba Prefecture in the two cities of Kisarazu and Kimitsu. In March, in this same park, a four-story (plus one underground story) research wing and a two-story health care wing were completed. Research equipment is now being set up, and the official opening will be in October. There are currently 56 members of the research staff, and this will reach 70 by October.

Chiba Prefecture established the "Kazusa DNA Research Institute" in 1991, led by Kyoto University Honorary Professor Mitsuru Takanami, and work began on constructing the facilities. Since January they have been publishing a research journal in English, named "DNA Research", which has one issue every two months.



The Kazusa DNA Research Institute, opening in October. (Kisarazu City, Chiba Prefecture)

Teikyo University Develops New Chromatography Method to Separate Long, Short DNA

94FE0765F Tokyo NIKKAN KOGYO SHIMBUN in Japanese 16 Jun 94 p 6

[Text] Professor KenUichi Kasai and Instructor Jun Hirabayashi of the Pharmacology Department at Teikyo University have developed a new chromatography method for separating and analyzing deoxyribonucleic acid (DNA) of different lengths. The new method is based on the idea that smaller strands of DNA will move more quickly through a column packed with particles of filling material.

Compared to the usual, manual form of gel electrophoresis, the new method is better with regard to measurement time, ease of operation, and accuracy, and it also can be automated. It is also interesting because it can be applied to long, thin substances such as polymers.

In the usual method of chromatography, the mixture to be separated is poured together with a solvent into a column packed with particles of filling material, making use of the chemical affinities of these substances. In other words, the components of the mixture that come out first are the ones with less affinity for the filling material particles and more affinity for the solvent. The new method, however, makes use of the fact that smaller strands of DNA will move more quickly through the spaces between the filling material particles than will the longer strands. So, as opposed to the usual methods, it makes no difference what the filling material particles are composed of. Rather, it is the size of the particles that matters, as well as the viscosity and velocity of the solvent.

The length of DNA and the time it takes to come out of the column can be compared to a downhill ski race, where what matters is the size of the ski and the speed down the slope, so the new method has been named "slalom chromatography".

The new method has been used to separate three sizes (3 microns, 7 microns, and 16 microns) of DNA fragments from bacteriophages, which are used in genetic engineering. The normally coiled DNA fragments stretch out when passed down the column, and the differences in their lengths become apparent. In one second, if they move one millimeter, then they have to slide around 120 filling material particles with a diameter of 10 microns, and separation occurs because the shorter fragments move more quickly.

Gel electrophoresis is usually used for DNA separation. The gel network is used as a sieve as the smaller DNA strands are pulled more quickly via an electric force. However, this method requires a long measurement time (one to two hours), the accuracy and reproducibilty are poor, the method is not quantitative, and the materials cannot be recovered, so it has many disadvantages. On the other hand, the new method can use the normal chromatography equipment, measurements only take from a few minutes to 20 minutes, and most of the disadvantages of gel electrophoresis are gone.

At present it is only possible to separate DNA whose length is between 5,000 and 50,000 bases. If this can be overcome, then it should be possible to automate the job of DNA analysis which currently requires a lot of manual work.

Zeneka, U.S. Company Sign License Contract for Plant Gene Recombination Technologies

94FE0765G Tokyo NIKKEI SANGYO SHIMBUN in Japanese 8 Jun 94 p 1

[Text] Zeneka and the American bio-venture company DNA Plant Technology (DNAP) have signed a cross-licensing agreement for plant gene recombination technologies. They each will be able to use a technology that the other one owns for developing fruits and vegetables, in order to aid plant development.

DNAP will provide "trans switch" technology for controlling plant genes. This technology makes copies of the same genes that exist within plants and then inserts them back into the plants so that the original genes stop functioning. In this way it is possible to control qualities such as ripening time, sweetness, color, and chewiness. A patent has already been obtained. Zeneka will be able to use the technology in areas other than the plants that DNAP is developing.

Conversely, DNAP will obtain ethylene control technology from Zeneka. This is a technology for controlling ethylene, which plays an important role in plant ripening, and DNAP will have the right to use this technology with all types of plants.

Since the technology currently owned by DNAP is considered the more valuable of the two, Zeneka will also pay a certain royalty for use of the patent. Financial details were not disclosed.

University of Tokyo, U.S. Company Sign R&D Contract for Gene Therapy for Cancer Treatment

94FE0765J Tokyo NIKKEI BIOTECHNOLOGY in Japanese 20 Jun 94 p 4

[Text] The American gene therapy venture company Somatix Therapy, located in Alameda, California, and Shigetaka Asano, Professor of Pathological Pharmacology in the Medical Research Laboratories of Tokyo University, have announced the signing of a joint research agreement for a gene therapy that inserts the gene for granular macrophage colony stimulating factor (GM-CSF), developed by Somatix, into cancer cells taken from patients, then puts the cells back into the patient in order to activate the patient's cellular immune system to treat the focal point of the cancer. This is the second such contract in Japan, the previous one being that signed in December, 1993 by Assistant Professor Yoshiaki Moriyama of the High Density Sterile Therapy Department of the Niigata University Medical School with the American company named Genetic Therapy.

Since Japan does not have a governing body to determine the safety of vectors, gene therapy experiments are currently being imported from the United States, which leads the way in gene therapy. This new agreement is related to previously conducted joint research involving clinical trials, and shows that Japan is seriously undertaking research into the use of GM-CSF gene therapy. In Europe and America this is considered fundamental research, and joint research agreements among businesses and academia are commonplace.

Professor Asano is currently planning clinical use of GM-CSF on terminal kidney cancer patients at four installations involving the National Cancer Center, Juntendo University, and Tsukuba University. Intensive meetings have been taking place once per month since last year to put together a joint clinical trial plan (protocol). These meetings include personnel who studied abroad in America and worked at the cancer research institute within America's Mt. Sinai Medical Center, which is where the GM-CSF gene therapy for Somatix was developed. The protocol work is now nearing completion. Incorrect reports have been published in newspapers, saying that this work is complete and has been presented to the Ministry of Health and Welfare. In fact, proposals to ethics committees and gene therapy investigative bodies at the various installations will be made in mid-summer at the earliest.

Tohoku University Discovers New Enzyme Using Gene Engineering

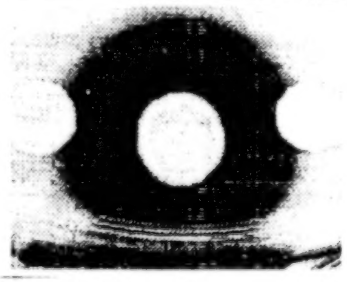
94FE0765H Tokyo NIKKEI SANGYO SHIMBUN in Japanese 10 May 94 p 4

[Text] A research team in the Agriculture Department of Tohoku University using methods of genetic engineering has discovered a new enzyme that can be used as a cleanser. It is a type of enzyme that breaks down proteins, and it functions in an alkali environment. Up until now, methods involving genetic engineering have not generally been used to search for commerically useful enzymes, but genetic engineering is in fact more effective than previous methods. The success that Tohoku University has had in these experiments should encourage the use of genetic engineering in the search for enzymes.

The team led by Professor Eiji Ichijima at Tohoku University used the "shotgun" method to cut apart bacterial genes. The gene fragments were introduced into Escherichia coli to produce proteins, and from those proteins enzymes that could break down protein were selected.

From the proteinases so obtained, a previously unknown one was separated. This enzyme was found to function even in alkali, in addition to being stable under a wide range of conditions, including acidic or neutral environments. It is expected to be an important enzyme for cleansing applications because of its ability to withstand an alkali environment.

The usual method of searching for new enzymes up to now was to gather and analyze enzymes secreted by various bacteria. With such methods it was first necessary to purify the enzymes before their genetic sequences could be determined. On the other hand, the shotgun method simultaneously obtains the enzyme and the gene that creates it, which is a more efficient approach. Bacteria also contain enzymes that they don't secrete, and the new method also makes it possible to discover and study such enzymes. In fact, Professor Ichijima has discovered such an enzyme found within bacteria.



A colony of Eschirichia coli (center) that incorporates the gene for the new enzyme breaks down the protein in the surrounding area (black portion). On both sides are colonies of Eschirichia coli that do not contain the gene for the enzyme.

AIST, Japanese Companies Launch Functional Protein Aggregate Application Technology Project to Develop Microcell Reactors

94FE0765I Tokyo NIKKEI BUSINESS in Japanese 20 Jun 94 pp 60-62

[Text] Atificial cells have functions superior to those of natural cells, by combining various functional proteins. Perhaps if this continues, some day there will be man-made living organisms? Biotechnology research is now underway with the possibility of making that dream a reality. It is an ambitious plan to analyze the functions of living cells in order to produce a completely man-made cell.

A Comprehensive System Involving Multiple Bioreactors To Go From Raw Materials To Products

This research is being promoted by the "Functional Protein Aggregate Application Technology" Project, an effort of the Agency of Industrial Science and Technology (AIST) of the Ministry of International Trade and Industry (MITI), in cooperation with private industry. The present goal is to use artificial cells to efficiently produce various chemical substances and pharmaceuticals. In other words, the aim is the construction of artificial cell factories. Such cell factories are called "microcell reactors".

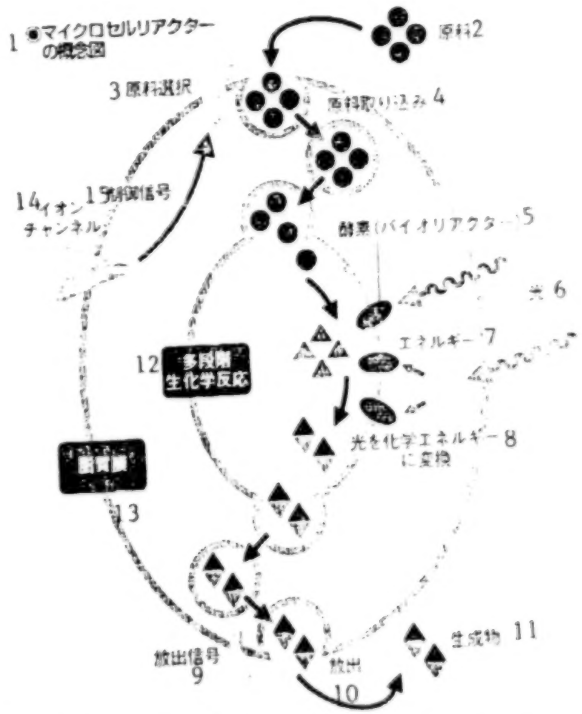
Living cells ingest necessary substances from outside the cell and use chemical reactions to convert those ingested substances into other substances. We can make use of such cellular functions to produce other desired substances as well. If successful, an abundant supply of various chemicals and pharmaceuticals could be produced from a single, small cultivation tank, rather than a large-scale chemical plant. There will no longer be a need to consume vast amounts of electricity or other sources of energy. It will also be possible to produce various proteins and genes that other technologies have not been able to produce up to now.

The technology known as a "bioreactor" is currently used to produce pharmaceuticals. Although this is a technology that uses enzymes to produce biochemical changes in substances, a bioreactor only conducts one particular kind of reaction. On the other hand, a long sequence of chemical reactions may be necessary to go from raw materials to a desired end product, so in fact a bioreactor only realizes one of the necessary steps.

A microcell reactor combines multiple bioreactors. Continuously performing a sequence of chemical reactions, it is a comprehensive system to go from raw materials to end products. A microcell reactor can also automatically identify and take in the raw materials, and the energy required for the reactions can be obtained from intracellular reactions such as photosynthesis. In a cell with a diameter of only a few microns (1 micron is one-thousandth of a millimeter), a complete factory can be set up for purifying raw materials and processing them, including the incorporation of a power source.

"Industry wants to be able to miniaturize without using up natural resources, and make products without using energy. Biotechnologies that are self-sufficient, self-transforming systems of production can make this possible." Thus explains the project leader Jun Miyake, who is the research director of the Bioengineering Industrial Technology Laboratory of the Agency of Industrial Science and Technology. Besides efficiently producing pharmaceuticals, such biotechnological systems will have a wide variety of applications, allowing us to conserve natural resources and to save energy.

A Single Artificial Cell Has Functions Rivalling Those Of A Chemical Factory



Key: 1. Conceptual design of a microcell reactor; 2. raw material; 3. raw material selection; 4. raw material ingestion; 5. enzyme (bioreactor); 6. light; 7. energy; 8. conversion of light to chemical energy; 9. extraction signal; 10. extraction; 11. end product; 12. multi-step biochemical reaction; 13. lipid membrane; 14. ion channel; 15. control signal.

The Technology For Bringing Raw Materials Into A Reactor Makes Use Of Immune Cell Functions

The research project began a 10-year plan in 1989. The first four-year stage of the plan was completed in 1992, and the second stage was begun. The first stage was concerned with studying various individual functions of cells, conducted at various laboratories by seven participating companies and AIST, in order to develop the fundamental technologies needed.

Those fundamental technologies included learning how to run multi-step biochemical reactions and how to develop the lipid for the outer wall of the artificial cell. The most difficult aspect, however, was the method for bringing raw materials into microcell reactor. Under the direction of Chugai Pharmaceuticals, the research goal was to select and bring into the reactor the desired raw material out of a variety of other materials.

The researchers studied macrophages, which are a type of immune cell that performs functions such as fighting bacteria that cause disease. Macrophages are amoeba-like cells that exist in blood and most of the other tissues of the animal body, recognizing and digesting specific proteins and bacteria. Microcell reactors would like to imitate that function.

A goal of the first stage of the research was to duplicate macrophage functions. The part of the macrophage that recognizes and reacts with a specific bacteria or protein is called the receptor. The researchers succeeded in extracting the gene for a human macrophage receptor that reacts with a certain protein, transplanted it into mouse macrophages, and saw that the human macrophage function was reproduced.

This technology is crucial for bringing raw materials into microcell reactors. If a microcell reactor can be given the same ability as seen in macrophages to ingest a specific substance, it will automatically bring the raw materials inside the reactor. Currently it is necessary to first purify the raw materials in order to bring about a chemical reaction, but that necessity will disappear if the ability to take in the raw material automatically can be realized.

When a macrophage recognizes the target protein, the first thing that happens is that the calcium ion concentration within the cell changes. This is the trigger that causes the protein to be ingested. However, the method by which the macrophage changes its shape like an amoeba in order to ingest the desired protein is still unclear. This method must be understood and artificially reproduced in order to develop future microcell reactors that can ingest raw materials automatically.

A Successful Trial Manufacture of a Solar Battery Using Plant Photosynthesis

Participants such as Stanley Electric and Toray Research Center are developing systems for supplying energy by using photosynthesis. During the first stage of the project they used photosynthetic proteins to produce energy similar to a solar battery.

There are two forms of photosynthesis. The "hydrolytic type" produces electricity by using light to decompose water, while the "organic compound analytic type" produces electricity by using light to decompose organic compounds. Higher plants use the hydrolytic type, while bacteria use the organic compound analytic type. The organic compound analytic type of photosynthesis has the characteristic that the photosynthetic protein is easily removed from the organism and easily handled thereafter. Stanley Electric worked together with the Bioengineering Industrial Technology Laboratory of the Agency of Industrial Science and Technology for the trial manufacture of a solar battery using the organic compound analytic type of photosynthesis. The solar battery

The Problem Of Bringing Together The Necessary Fundamental Technologies

1 ●プロジェクトの参加企業と研究テーマ

2 企業名	3 研究テーマ
4 スタンレー電気 5 東レリサーチセンター 6 三菱油化	7 光のエネルギーを化学エネルギーに変換するシステム
8 中外製薬	9 原料となる物質を選択して，マイクロセルリアクターに取り込むシステム
10 花王	11 多段階の生化学反応
12 三菱化成	13 原料物質を認識して取り込みを始める信号を送るイオンチャンネル
14 クラレ	15 生成物をマイクロセルリアクターの外に放出するシステム

16 注：クラレは92年度で終了した第1期のみ参加

Key: 1. Participating Companies and Research Themes of the Project; 2. Company Name; 3. Research Theme; 4. Stanley Electric; 5. Toray Research Center; 6. Mitsubishi Yuka; 7. Systems for converting light energy into chemical energy; 8. Chugai Pharmaceuticals; 9. Systems for recognizing substances as raw materials and taking them into microcell reactors; 10. Kao; 11. Multi-stage biochemical reactions; 12. Mitsubishi Chemical; 13. Ion channels that act as signals for recognizing and initiating the uptake of raw materials; 14. Kuraray; 15. Systems for extracting products from microcell reactors; 16. Note: Kuraray only participated in the first stage of the project, which ended in 1992.

for this trial manufacture is a thin film of the photosynthetic protein on a glass substrate. However, the photosynthetic protein contains positive and negative charges, and the battery only functions if the charges are correctly aligned. If the protein is thinly spread out on a water surface it automatically assumes the proper configuration, and then the protein is gathered up. When light shines on the solar battery constructed in this way, a current of up to 400 microamperes is produced per square centimeter.

On the other hand, Toray Research Center is using the hydrolytic type of photosynthesis. They succeeded in analyzing the gene for the required protein and in using Eschirichia coli to mass-produce it.

Photosynthetic solar batteries will be used within microcell reactors to provide energy for the bioreactors.

In addition to the activities mentioned above, Kao is finding ways to continuously run a wide variety of biochemical reactions, and Kuraray is developing methods for extracting the end products that are produced by reactors. Each of these research themes achieved most of its initial objectives during the first stage of the project.

During the second stage of the project, which began in 1993 and runs for three years, the participating companies and research organizations are further developing their respective research themes. In the third stage of the project, which will run for three years beginning in 1996, the plan is to combine the variously developed fundamental technologies into an integrated system.

It is said that Japan lags behind Europe and America in biotechnological research. However, it is only in Japan that ideas have progressed to the point of integrating biological technologies into revolutionary production systems like microcell reactors. As Research Director Miyake explains: "Microcell reactors are basically an assembly line technology. Even in biotechnology, Japan and Germany have the best assembly line technology."

Artificial Skin and Lenses for Medicine; LSI Manufacture at the Molecular Level

Microcell reactor technology is not just useful for production systems. The same reactors are also expected to have medical applications, since that is another field that also requires man-made cells. Possible applications could include cells with the same functions as red blood cells to use in blood transfusions, or cells with the same functions as human skin to use in treating burns. Artificial cells that resemble the lens of the eye could be used to treat cataract, the condition that causes blindness when the lens becomes opaque.

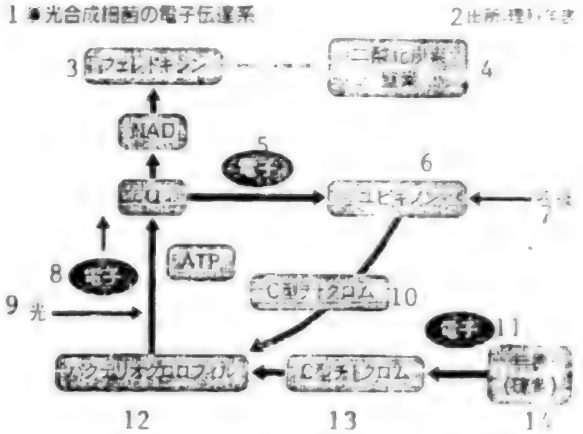
Microcell reactor technology is also expected to influence other areas of research, since technologies for manipulating and controlling substances right down to molecular or atomic level are required. For example, in the research that built the photosynthetic solar battery, the Langmuir Blowjet technology for constructing films as thin as a single molecule was used.

Not only in biology, but also in electronics, as the degree of integration increases in large-scale integratic circuits (LSI), technologies are sought for processing substances at the molecular or atomic level. Work is underway to build circuits as small as a single molecule, and the same can also be said of micro-machine construction. "Even more than microcell reactors, the fundamental technologies for manipulating molecules are themselves a commercial necessity." (Research Director Miyake)

This research project will end in 1998, but it will probably take 30 to 40 years before true microcell reactors become a reality. "First, functions will be added to existing bioreactors, and some of the functions of microcell reactors will be realized with biological cells. Those will probably the first applications," predicts Tsugio Matsuo, managing director of the Biotechnology Development Technology Research Union, the executive office of the project.

The idea of microcell reactors, creating various proteins and combining them into artificial cells, can greatly widen the scope of biotechnology. Although this research project may be considered ambitious, those who are watching the development of Japanese biotechnology are eagerly wondering how much of it will come true.

Self-Sufficient Production of Energy Using Photosynthesis



Key: 1. Electron Transport System in Photosynthetic Bacteria; 2. source: Physical Sciences Yearbook; 3. ferredoxin; 4. carbon dioxide and nitrogen; 5. electrons; 6. ubiquinone; 7. absorption; 8. electrons; 9. light; 10. cytochrome C; 11. electrons; 12. bacteriochlorophyll; 13. cytochrome C; 14. inorganic compounds (sulfur).

MITI, EA to Begin Full-Scale Bioremediation

94FE0652A Tokyo NIKKAN KOGYO SHIMBUN in Japanese 18 Apr 94 p 5

[Text] The Ministry of International Trade and Industry and the Environment Agency are going to seriously

tackle the issue of bioremediation by freely using biotechnology. Presently, they are proceeding to cooperate with private research organizations regarding the development of recovery methods using microorganisms on the contaminated atmosphere and earth. If they find it practical, they will then establish guidelines. OECD has a meeting in Japan in November regarding bioremediation, so both ministries want to use the meeting as a springboard to tackle these questions in Japan.

Bioremediation is the technique of removing harmful materials by utilizing the decomposition action of microorganisms. It is in practical use in Europe and America, but it is still in the research and development stage in Japan. Following this trend, the OECD workshop will be held in Tokyo from 27-29 November. The risks and safety concerning bioremediation, standards for measuring the effects of restoration, and the role that biotechnology will play in improving the environment will be discussed at the workshop. It is the first time that OECD has held a meeting with the theme of bioremediation.

The atmosphere, water, oceans, underground water and soil are the objects of bioremediation. The safety and effects on other environments when using microorganisms with rearranged genes will be discussed at the meeting. In addition, opinions will be exchanged regarding how much restoration should be completed and whether the "natural state" should be judged as the moment when microorganisms return.

Problems associated with contaminated soil include trichloroethylene, cadmium and chromium. Since we in Japan are just at the stage of research development, the Ministry of International Trade and Industry and the Environment Agency have considered actively assisting research and development by private research organizations.

Moreover, both ministries hold that guidelines are required for their actual use.

OECD has been discussing the safety of gene-altered agricultural products, but just before safety standards were completed, it selected the theme of bioremediation. Both ministries intend to actively incorporate examples from Europe and America.

CRIEPI Develops Desulfurization Technology Using Microorganisms

94FE0652B Tokyo NIKKEI SANGYO SHIMBUN in Japanese 21 Mar 94 p 4

[Text] The Central Research Institute of the Electric Power Industry Inc. has developed a new technique of desulfurization of coal that uses microorganisms. It raises the quality of high-sulfur-content coal, which causes contamination of the atmosphere. In experiments, 70% of the inorganic sulfur fraction as well as 60% of the ash fraction were removed. It is necessary, for practical application, to develop process technology that treats a large amount of coal continuously. This is easy to accomplish in principle, and its use seems feasible even in underdeveloped countries where expensive emission desulfurization equipment is not installed.

In the new method, fine powder coal and iron-oxide bacteria, which like sulfur, are mixed in water and air is blown in from below. The coal fraction floats with air in the water, but the inorganic sulfur fraction (iron pyrite) is readily separated by sinking in water because bacteria attach to it, enhancing its miscibility in water. The ash fraction also sinks.

In experiments with Pittsburgh coal, which has a comparatively high sulfur content of 2-3% and an ash content of approximately 10%, the sulfur fraction and ash were removed in several minutes. It can be said that half of the total sulfur was removed in advance since the sulfur fraction includes organic sulfur.

Recently, steam-fired power plants in Japan have begun to use a coal-water mixture (CWM) fuel comprising fine-powder coal mixed with water to form a liquid fuel. The product of the current technology can be used as is since water is not removed at the end.

From now on, the Central Research Institute of the Electric Power Industry will pursue research to permit desulfurization and ash removal to be carried out continuously.

Japanese Companies Develop Wastewater Treatment Technology Using Bioprocessing

94FE0652C Tokyo NIKKAN KOGYO SHIMBUN in Japanese 25 Mar 94 p 14

[Text] Nishihara Environmental Sanitation Research Corp., a large water treatment company (Tokyo-to Minato-ku Shibaura 3-6-18, president-Keiichiro Tanaka Tel-(03) 3455.4821), in cooperation with The Nissin Oil Mills, Ltd. (president Mitsuo Fukawa), has succeeded in developing a bioprocess in which wastewater containing high concentrations of oils and fats is directly processed biologically using yeast. This is a method of direct treatment in which oils and fats in wastewater are consumed by yeast, without adding physical or chemical treatment. It can handle wastewater with high concentrations of oils and fats on the order of 10,000 ppm. It is an energy-saving system in which the initial costs and the running costs are drastically reduced. At present, a pilot plant is being tested at the Yokohama Factory of The Nissin Oil Mills, Ltd. Full-scale operations are planned to commence in 1995.

When processing high-concentration wastewater with a content of oils and fats exceeding 100 ppm in the conventional method, a flocculent has been admixed followed by pressurization so that the oils and fats would form a waste-oil froth that is separated and removed. The separated liquid would then be subjected to post-processing by the activated sludge method using bacteria. That constitutes the general method. However, the waste-oil froth that is generated in the pretreatment stage

can only be treated by burying in a landfill or incineration, either of which poses environmental problems. A factory which treats 500 tons of wastewater a day had approximately 5 tons of waste-oil froth, 1/100 of 500 tons, yet it was a source of anxiety to the operators.

Numerous types of yeast are mixed and used in this new process, focusing on the Candida genus including Candida shataby [phonetic transliteration], Candida tropicalis, and Candida helenica. As such yeast consume these oils and fats, the oils and fats become part of the yeast. The oil-and-fat content must fall below 30 ppm before liquid can be released into sewage, but yeast treatment alone is adequate to reach this level. Activated sludge treatment must be combined as posttreatment before the liquid can be released into rivers or oceans.

The main characteristics are:

1. There is no need to dispose of waste oil, so there is no worry about environmental contamination.

2. Compared to conventional processes, the initial costs are 30% lower and the running costs are 70% lower.

Nishihara is planning to modify and miniaturize this system before putting on general sale a treatment process for wastewater with a 200-400 ppm content that is usually discharged from commercial kitchens of hotels and restaurants.

Sagami Chemical Research Center Starts Research on Gene Introduction for Plants

94FE0652D Tokyo KAGAKU KOGYO NIPPO in Japanese 6 Apr 94 p 5 14

[Text] Sagami Central Chemical Research Laboratory (Director Teruo Yawata) has begun joint research on the incorporation in plants of genes related to the biosynthesis of eicosapentaenoic acid (EPA). A gene extracted from the EPA-producing bacteria that was discovered by this research group headed by the chief researcher, Ryoichi Yazawa, will be inserted in rice plants or tobacco plants. For this reason, it concluded a joint research contract with two major plant-biotechnology companies in Japan. It is also examining cooperation with big plant-bioventures in the United States.

A group headed by chief researcher Ryoichi Yazawa at Sagami Central Chemical Research discovered eicosapentaenoic acid (EPA)-producing bacteria in the intestines of fish in 1987. Subsequently, it extracted genes involved in EPA biosynthesis from this bacterium, introduced them into colon bacillus two years before, and succeeded in producing them. Also, the entire base sequence was determined.

This research center concluded a joint research contract with two big plant biotechnology companies in Japan in order to introduce genes involved in EPA biosynthesis into plants. Until now, EPA has been available only from fish like sardines, so we expect to be able to constantly ingest it in rice or vegetables.

EPA first attracted attention when we noticed that few Greenland Eskimos, who eat a large quantity of fish, develop thrombic disorders such as myocardial infarction. Later, various tests, including pharmacological tests and clinical trials, revealed that it has a potent suppression of platelet aggregation. It went on sale in Japan in 1990 as a drug indicated for the treatment of arteriosclerosis obliterans (Epadel from Nissui Pharmaceutical Co., Ltd. and Mochida Pharmaceutical Co., Ltd.). In addition, it is thought to have such biological activity as anti-inflammatory action and suppression of cancer development.

EPA has these physiological activities, but until now it could only be ingested from fish oil, so fish oil has been extracted and refined for drug use. Also, EPA, which is not synthesized in the body, is only ingested through food. Thus, it has been known to be extremely difficult to synthesize chemically.

Two companies which have entered into joint research will first try to introduce it into rice plants and tobacco plants. Lettuce or Chinese cabbage will be the objects in the future. In addition, a major American plant bioventure is seeking joint research to introduce it into rape.

Research Center Extracts, Purifies Protein, Lectin From Algae

94FE0652E Tokyo KAGAKU KOGYO NIPPO in Japanese 1 Apr 94 p 8

[Text] The Algae Resource Center (Aichi-ken Iyo-shi, President Takakazu Ichinomiya) has recently succeeded in extracting and purifying large amounts of Lectin, a protein with lymphocyte activation properties, from Eucheuma serra, algae in the Eucheuma genus. Until now, Lectin has been extracted from beans such as soybeans or beetles (Allomyrina dichotoma), but it has been difficult to obtain and the quantities have been very small. That has created a bottleneck for research and practical application. Lectin, which was found in algae, has been found on the test-tube level not only to have the function of lymphocyte activation, but to also suppress increase in cancer cells. Therefore, with the expectation of application to drugs, animal experiments are planned in order to complete practical application. This is a project financed for 1990 by the Organization for the Promotion of Research on Specific Biological Industrial Technology. The research center is participating in a cooperative venture with nine private companies that include Yamaki, Nissan Construction and Sumitomo Chemical Co., Ltd.

Lectin is the generic term for a glycoprotein, a protein that is bound to sugar. Sugar-related substances condense or precipitate. The molecular weight of Lectin that has been found until now has ranged from 100,000 to several 100,000, but the material extracted currently is a monomer lacking sugar molecules with molecular weight of 25,000 to 30,000. It is stable in the range of pH 2 to 10 and does not require specific metal ions to induce its function. Therefore, when selling it as a drug, it can be administered orally.

It was confirmed in test-tube experiments to activate mouse- and human-derived lymphocytes. Furthermore, it specifically binds to cancer cells including solid cancer (HeLa cells) as well as to lymphatic cancer, and suppresses their growth. In addition to the development of cancer control drugs, for example, it will be applicable to clinical diagnosis, as in measurement of the immunity function in AIDS patients and of cancer metastasis. We can also expect enhancement of the immunity function. In the future, verification of the effects on the level of animal experiments will be tackled, and basic research into structural analysis and clarification of the functions of Lectin will be promoted.

This research center was established for the development of extraction and refining technology of the effective ingredients from southern algae, on which research lags in comparison to research on northern algae such as sea tangle. After screening about 200 kinds of algae, Lectin was found in 95%, a very high rate, of all proteins in Eucheuma serra. Ninety-nine percent pure Lectin is obtained by solvent precipitation and gel filtration. The recovery rate of a peak of 1 g from 100 g of Eucheuma powder is 100 to 1000 times higher than that of prior Lectin extraction methods. The Eucheuma genus is known to comprise carrageenan raw materials. Eucheuma serra is found in the waters near Japan, such as Tokushima and off the coast of Kochi prefecture.

Kirin Beverage Develops Technology to Identify Agricultural Products by Gene

94FE0652F Tokyo NIKKEI SANGYO SHIMBUN in Japanese 14 Apr 94 p 1

[Text] Kirin Beverage, the branch of Kirin Beer that produces and sells beverages (Tokyo, Chiyoda, President Takeo Tsuya) developed technology to precisely identify the variety of agricultural product based on genetic differences. The procedure is first to discover the part that differs greatly, based on the variety, in the sequence of bases that comprise DNA (deoxyribonucleic acid), the unit that communicates genetic information, and to then identify the variety. A patent application for identification of oranges was submitted, but the application to other fruits such as pears and apples or to grains is also possible. Until now, specialists for taste and aroma have confirmed the variety of agricultural products brought in from foreign countries, but the identification accuracy will rise using this new technology and it will contribute to enhancing the quality and taste of agricultural processed goods. (Consult "One word in industry" regarding DNA)

What was developed is technology that identifies the variety from differences in the sequence of bases. There are dozens of varieties of oranges, including valencia, hamlin, verna and Nagashima, and they can now be correctly identified in only three hours. Identification took approximately 15 hours before involving analysis of taste, smell and composition, and the identification was not accurate. The efficiency has been raised significantly by this procedure.

DNA is constructed from thousands to tens of thousands of bases. It was discovered that the part having the function of synthesizing protein varies greatly depending on the variety. That part is picked using DNA which was synthesized separately, and the number is increased by repeating the separation operation.

Then, patterns varying with the variety which can be identified macroscopically appear following the application of a charge to an aqueous solution. The variety can be precisely identified by comparing these. The variety can be determined from a slight amount of juice, and testing is easily carried out.

Identification of agricultural products procured from abroad has been difficult because similar varieties have been admixed. Precise identification has not been possible even when analysis results of such constituents as acidity and sugar have been considered in addition to checks of flavor and aroma by specialists. Furthermore, picking samples from large shipments and testing them has not always been possible because of the trouble and time involved in testing. Since low-quality varieties have been admixed in shipments, the precise identification of varieties has been a major concern of food manufacturers.

Kyoto University Develops Edible Biodegradable Plastic

94FE0652G Tokyo NIHON KOGYO SHIMBUN in Japanese 6 Apr 94 p 7

[Text] Avid stares from every direction

Biodegradable plastic that can be decomposed by microorganisms has attracted attention, but now another "new face" has appeared in the lineup. It is an "edible biodegradable plastic" whose raw material is protein that was developed by the research group at Kyoto University, Food Science Research Laboratory. It has attracted considerable attention from every direction since its raw materials can be wastes from food manufacturing plants.

Because of the rise in the trend toward protection of the environment, the market for biodegradable plastic is expected to grow to 100 billion yen by the year 2000 and to 500 billion yen by 2010 (predictions of the Economic Planning Agency). The development of various "environmentally-friendly plastics" which use natural material or chemically synthesized matter as the raw material is being pursued. Biodegradable plastic derived from food whose main material is starch has already been merchandised as "Matabii" made by Novamont Co. of Italy (imported and sold by The Nippon Synthetic Chemical Industry, Co., Ltd.) and Novon made by Warner Lambert Inc. of the United States (imported and sold by Chisso) etc., and has been put to use.

However, since protein burns before melting when heated, its conversion to plastic has been said to be impossible.

The research group of Etsushiro Doi, former professor at Kyoto University Food Science Research Laboratory (presently professor at Kinki University, Department of Physical Engineering), added water at a ratio of several % to 10% into refined soy bean protein and put this into a sealed cylindrical container from which water does not evaporate even at high temperatures. By heating for five to ten minutes at a temperature of 150 to 160xC, the protein dissolved without burning, and plastic was successfully formed.

Both transparent and opaque

In addition to soy beans, such proteins as egg whites, milk, corn and cow blood have been used successfully in plastic formation. The resulting plastic can be made transparent or opaque by adjusting the pH (degree of acidity and basicity).

If the amount of water is high, it would fuse (dissolve) at a comparatively low temperature. Professor Doi says, "It is similar to the phenomenon of the melting temperature (glass transition temperature) of synthetic polymers dropping in the presence of plasticizers."

If plastic made of soybeans or egg white albumin is pulverized and reheated with water, it can turn into plastic again. This material has thermoplastic properties.

Permissible solvents include glycerol and ethylene glycol in addition to water.

Various plastics ranging from hard plastic to viscoelastic plastic which resembles chewing gum can be provided by altering the type of protein, the pH and the solvent. In addition, the professor also states, "We have also succeeded in manufacturing transparent film plastic.".

The waste from food processing plants is applicable as the raw material. Since such material can be turned into plastic without using harmful chemicals, it can be reused as feed for domestic animals or as plant fertilizer. Even if fish eat it after being discarded in the oceans or rivers, there is no cause for worry because it does not harm fish.

Looking into the future, the professor thinks that it could be used in the field of medicine as medical capsules which dissolve at specific sites in the human gastrointestinal tract or as a substitute splint that melts and disappears after burying inside of the body.

However, it will mold or rot if used in any atmosphere with a high moisture content. Preservatives must be added to permit long-term use in the environment.

The raw material is natural material close at hand

"Bioval" from CI Industries of the UK made of butyric acid and valeric acid and "Bionoray" from Showa Highpolymer Co., Ltd. synthesized from petroleum raw materials are other examples of biodegradable plastic in addition to the plastic using starch as raw material that has been presented.

In addition, the Shimadzu Corporation plans to sell "Lacty", plastic made using lactic acid as the raw material, in June of this year.

Various other biodegradable plastics are being researched in addition to these, and there are fresh candidates developed by food science laboratories that use natural raw materials that are close at hand. We eagerly await future developments based on results from areas that we had thought were forever closed. (Takeshi Yamashita)

MAFF Creates Barley Using Genetic Recombination

94FE0652H Tokyo NIHON KOGYO SHIMBUN in Japanese 5 Apr 94 p 6

[Text] The Ministry of Agriculture, Forestry and Fisheries, National Institute of Agrobiological Resources (Director Mr. Hiroshi Fujimaki) has succeeded in creating barley that has undergone gene recombination through the use of a particle gun.

Gene recombination on members of the rice plant family, beginning with barley, is generally difficult, but the research group says, "We have proven that recombinant forms can be easily produced using particle guns."

There have been two reports of recombinant forms of barley using particle guns, but this is the first case in Japan.

The particle gun is used in a technique in which a minute metal particle covered with genes is shot into a cell to alter the genetic arrangement. This does not require the skill of conventional technology, and it therefore simplifies the completion of recombinant forms. It was developed in America in 1988, and it came into use in Japan beginning in 1992.

In an experiment, a gene that is resistant to the antibiotic Hygromycin was shot by a particle gun into an immature germ that was removed from a barley seed.

The immature germ into which a gene had been shot was cultured in agar medium to which Hygromycin had been added. Ordinarily, the presence of Hygromycin would cause an immature germ to wither, but the immature germ into which this gene had been introduced then developed roots, leaves, and grew satisfactorily. This confirmed that the gene had been replaced.

Among members of the rice plant family, it is especially difficult to make recombinant forms of barley. The method of creating a protoplast (naked cell in which the cell wall on the surface is dissolved by enzymes) followed by opening a hole in a cell by electric pulse and inserting genes therein has also been attempted, but the plant withers during the procedure and it cannot be restored to the original form.

The group plans next to introduce into barley a gene with resistance to viral diseases using a particle gun.

University of Tokyo Develops Artificial Enzyme to Cut RNA

94FE0652I Tokyo NIHON KEIZEI SHIMBUN in Japanese 21 Mar 94 p 13

[Text] The research group of Professor Makoto Komiyayama et al. from Tokyo University, Department of Engineering, has succeeded in developing an artificial enzyme that can cut RNA (ribonucleic acid), the acid responsible for carrying out the important role of protein synthesis of organisms, at any desired spot. There are natural enzymes that cut RNA, but an artificial "scissors" has never existed before. If we could complete designs in which the position to be cut can be freely selected to alter the molecular structure, new genetic engineering techniques would then become available, such as therapy in which RNA of the AIDS virus is cut to prevent its propagation. Research results will be presented at the annual spring meeting of the Chemical Society of Japan that begins on the 29th.

Professor Komiyayama et al. developed this based on the mechanism of natural enzymes that hydrolyze RNA. This enzyme functions jointly with acid and base in a single molecule. Therefore, they selected the compound ethylene diamine, which has the same function and a simple structure. They then created the enzyme through combination with DNA (deoxyribonucleic acid) which holds pairs of the RNA to be cut.

In experiments conducted on transfer RNA, it was possible to cut designed base sequences with virtually 100% accuracy. According to Professor Komiyayama, the DNA base sequence should be altered when applying this artificial enzyme so as to form pairs of RNA as though cut at the desired spot by artificial enzyme "like a scissors". Thus, if protein which binds specifically to RNA is bonded, the RNA to be cut could be reliably determined.

Accordingly, it seems possible to design material that is capable of cutting the RNA that acts in the growth of cancer cells or the RNA of the AIDS virus in which RNA itself constitutes hereditary information. Professor Komiyayama thinks there is a possibility of developing an AIDS treatment similarly to "Ribozyme" which cuts RNA by a type of RNA.

MAFF Develops Method to Introduce Gene to Rice Plants

94FE0652J Tokyo NIKKEI SANGYO SHIMBUN in Japanese 30 Mar 94 p 5

[Text] [Chikuba] The Ministry of Agriculture, Forestry and Fisheries, National Institute of Agrobiological Resources has developed a new, inexpensive, comparatively simple technique of introducing separate genes into rice plants. The damage to the cell is slight and the efficiency is improved in comparison to conventional techniques, which include electropolation in which holes are opened in cells by electrical pulse and genes are inserted, or the particle gun method in which minute metal spheres coated with genes are shot into cells. Genes could easily be introduced into tomatoes or tobacco via this technique.

The surface of a protoplast (protoplasm following removal of the cell wall of a plant) into which the target genes are to be inserted has a negative charge. The surface of a vector whose role is to transport the target genes also has a negative charge. Accordingly, it is impossible to introduce genes without some alteration, and this new technique succeeds in gene introduction by linking the two with a chemical substance termed poly-ornithine whose surface has a positive charge.

Approximately half of the cells are destroyed in the current course of gene introduction using the conventional technique, but the number of destroyed cells could be cut to zero by the new technique if the protoplast refining conditions remain unchanged, and doubling of the experimental efficiency is possible. Moreover, there is no need for expensive equipment that costs one million dollars or more, and it is expected that the cost of gene introduction could be cut to less than 1/100 of the previous cost.

The new technique is applicable to the plants of any family in which protoplast refinement is possible.

Tokyo Electric Power Co. Begins R&D to Make Paper Using Genetic Recombination

94FE0652K Tokyo NIKKAN KOGYO SHIMBUN in Japanese 10 Mar 94 p 1

[Text] Tokyo Electric Power Co., Inc. (president Hiroshi Araki) has set about research and development to make paper using recombined genes of algae, whose carbon-dioxide (CO_2) absorption capability is four times higher than that of tropical rain forests. Research into the separation/removal as well as processing/fixation of CO_2, which is one factor in global warming, has attracted world-wide attention, but this represents the first research and development in the world of cultivation through genetic rearrangement of algae, which are capable of efficiently absorbing large amounts of CO_2 through photosynthesis. If this becomes practical, not only would it permit absorption and fixation of CO_2, but it would also be linked to the protection of forests. Accordingly, it would have a great ripple effect.

The organism that Tokyo Electric Power Co., Inc. will use as the raw material in the production of paper is a microalgae inhabiting sea water, with a length of 3 microns, known as "Cyanophyceae cinechocystis". The Technical Research Laboratory, Global Environmental Laboratory of the company succeeded in collecting and culturing this microorganism from the hot springs along the coast of seven islands of Izu and Shikine Island.

This microalgae has very high CO_2 absorption capability, and its amount of photosynthesis is four times greater than that of a tropical rain forest. In other words,

it absorbs four times as much CO2 as a tropical rain forest when planted in the same area of land. In addition, it also absorbs sulfurous acid and nitrous acid, which are the main causes of acid rain, as its nutrients, and its speed of multiplying is high. Cell division occurs once every four hours at culture temperature of 45 degrees centigrade.

Research for making paper is going to be tackled as one of the techniques for CO2 biotreatment using these characteristics of microalgae.

A basic experiment in this research will be the introduction of genes from Acetobacter, a variety of acetic bacteria, into the microalgae. Acetobacter has the capability of producing the cellulose that is necessary to make paper. By this technology of genetic recombination, microalgae will become the raw material of paper if there is success in imparting the ability to make cellulose to the microalgae. Basic research has just started, but there is said to be a possibility of providing the microalgae with rearranged genes.

Tokyo Electric Power Co. believes that this microalgae, which has high CO2 absorption, reproduces at a temperature of 25 to 40xC in sea water. Therefore, a large amount of sea water is needed for mass cultivation, but since sea water is available, this seems to be a promising method of securing paper material.

JAMSTEC To Conduct Deep Sea Research Using "Kaiko"

94FE0652L Tokyo NIHON KEIZAI SHIMBUN in Japanese 26 Feb 94 p 10

[Text] On March first, the unmanned oceanic survey craft "Kaiko" of the Japan Marine Science Technology Center will attempt a challenging submarine voyage test into the Marianna trench, the deepest point in the ocean, where the depth of water is approximately 11,000 meters. It has been 34 years since the American manned submarine "Trieste" succeeded in reaching that depth in 1960. The ability to reach the ocean bottom around the world would vastly expand deep-sea research since it would make possible such operations as observation of the sinking of plates in the Japan oceanic trench.

The support mother vessel "Yokosuka" (4493 tons) upon which the "Kaiko" is loaded will leave from a port on Guam Island on the 27th for the test area. After the Kaiko has carried out pressure-resistance trials on the 28th at water depths of less than 10,000 meters, it will submerge twice, on March first and the second, at the Challenger trench (10,920 meters) which is the deepest in the Marianna oceanic trench.

The depth of water where the American "Trieste" once reached the bottom was 10,912 meters. There is an expectation that Kaiko will update that figure.

The Kaiko comprises a launcher approximately five meters in length and a vehicle approximately three meters in length. After the launcher combined with the vehicle have descended to a depth of 10,000 meters, the vehicle is launched from the launcher. The support mother vessel, launcher and vehicle are connected by cable. The vehicle can freely crawl around on the ocean bottom by the remote control from the support mother vessel.

The vehicle is fitted with observation equipment such as a manipulator which can pick up rocks, a high image-quality color television camera and a still camera so that a clear picture of the ocean floor will be sent up to the ship in real time.

Development of the Kaiko started in 1986 and was completed in 1992. Until now, tests have been completed in the sea near Japan. This current submarine voyage to the Marianna ocean trench is the final performance test before the manufacturer, Mitsui Leasing and Development, Ltd., transfers it to the Japan Marine Science Technology Center. The cost of development was ¥ 5.4 billion.

The Japan Marine Science Technology Center will carry out training to master the Kaiko system in 1994. Then it will examine deformation of the plates in the waters off the coast of Boso where the Pacific Ocean Plate, North American Plate and Philippine Plate meet, at a water depth of 9,200 meters. Secondarily, microorganisms found in the Marianna Ocean trench and the Izuogasawara Ocean trench will be collected.

The Japan Marine Science Technology Center is operating a manned surveying submarine "Deep Sea 6500" which can dive to 6,500 meters. Since Kaiko is unmanned, it can dive to far greater depths.

Fanuc Ltd. Develops High-Power Carbon Dioxide Laser

94FE0682A Tokyo NIKKAN KOGYO SHIMBUN in Japanese 29 Mar 94 p 15

[Text] Fanuc Co. (Seiuemon Inaba, President) has scored a victory in the laser business. They have developed a carbon gas laser oscillator for cutting that has a 6 kilowatt output used, and is said to be the highest in the world. They have also developed 1.5 kilowatt and 3 kilowatt oscillators that have been reduced in size and weight to about two thirds that of conventional devices, and they will begin supplying these to laser processing equipment manufacturers in April. In addition to this, they also plan to bring out a slab type YAG laser with an average output of 150 watts that can cut, bore holes, and weld all with one unit. With new product effectiveness and with development of an overseas market including China, they are aiming at a 30% increase over the prior fiscal year in anticipated sales for the laser business in the first quarter of 1995.

Among these new products, the 6 kilowatt device can cut ship and bridge building plate steel with a plate thickness of 16-32 mm. Moreover, in the past, plasma and gas flames were used in this field, but because lasers have the characteristics of a small cut and of little consumption of electrodes, it will be easy to incorporate them into automated systems.

Moreover, the 1.5 kilowatt "C1500B" and the 3 kilowatt "C3000B." which are successor machine types to conventional devices, can be applied to the cutting of thick plates of highly reflective material such as aluminum. These devices have been greatly reduced in size and weight by attaching a turbo blower fan and giving the high frequency emission excitation power source a compact design.

Furthermore, the "YP150A" YAG laser can not only cut, but can be generally utilized for boring holes and welding. It can even be supplied in forms for assembly into industrial robots.

JRDC Cites Achievements with New Atomic Manipulation Technology

94FE0682B Tokyo NIKKAN KOGYO SHIMBUN in Japanese 28 Mar 94 p 10

[Text]

Progress Toward Atomic Memory: Establishment of the World's First Elemental Technologies

The Aono Atomic Control Surface Project of the Creative Science and Technology Promotion Business of the Japan Research Development Corporation (Director of Development Masakazu Aono, Chief Researcher of the Institute of Physical and Chemical Research) has established elemental technologies for atomic scale memory (ASM). Readings of individual atoms were taken by scanning tunneling microscope, the readings were confirmed at room temperature, and for the first time a technology was developed which can measure these conditions in real time. Although there are many examples of research in which atoms have been manipulated and moved at room temperature, this is the first time in the world that an atomic manipulation technology has been developed by packing the necessary conditions into memory until noise control, which is linked to errors, is reached. This will give a great impetus to the realization of ASM, which is expected to become practical sometime in the 21st century.

All of Human Knowledge on a Single Mini-Disk

This research group has brought together the research achievements accumulated since 1985 to provide the indispensable conditions for the configuring of ASM.

Because the object of this research project is to independently manipulate individual atoms, it is called by the name of "atom craft," and the aim is an extremely ultra large scale memory device which will be born out of ASM or this so-called "atom craft." When this is realized, Chief Researcher Aono claims that "all human knowledge since history began can be recorded" on a mini-disk with a diameter of 64 mm.

To realize ASM, technology that can reliably manipulate single atoms and confirm this is important. Chief Researcher Aono expresses this as "the establishment of elemental technologies to strip off, give, move, and view individual atoms." In this current research of the group, a technology to manipulate silicon atoms on a 7x7 structure surface of silicon (111) was developed, and they were able to overcome the error problems which have an effect on the reliability on memory.

This technology has a mechanism resembling an STM probe by which a single atom is first extracted, and is then reintegrated. It is confirmed by the principle that electric field evaporation occurs when a given voltage is applied. In this regard, if electric field evaporation continues, several atoms are extracted. Eventually the extracted atoms fall back again much like a pen point that drips ink, and this produces the problem that the memory state is destroyed. This is resolved by providing a pulse voltage of extremely short duration which is just enough to move the atom that is hollowed out by the probe at the time of extraction, and let it fall back to another location.

In terms of writing, one method is to have the atoms of the probe tip itself come off. Another method is to have a pen with ink system in which ink is applied to the tip of the pen and the letters are written with that. This is thought of as a method of writing characters with ink that is continually supplied to the tip of the pen as happens with a ballpoint pen. There has been success with both of these methods. With the former method, it has been confirmed that ASM is effective

without the shape of the holes changing at the room temperature level even when the manipulations of accumulating and extracting atoms in atomic holes (the holes of extracted atoms) is repeated.

Continuous Writing Like a Ballpoint Pen

There has also been a proposal for a new technology which continuously writes with the convenience of a ballpoint pen rather than a fountain pen. When a platinum probe is exposed to a hydrogen gas atmosphere, hydrogen molecules (H^2) are released and only hydrogen atoms (H) can adhere to the probe. Hydrogen molecules cannot adhere to the silicon surface. A ballpoint pen type writing technology has been developed in which several hydrogen atoms are allowed to adhere to the point of a platinum probe in a hydrogen gas (molecule) atmosphere, and these hydrogen atoms are written one at a time continuously on the silicon surface.

Accumulation and Removal Observed in Real Time

On the other hand, the confirmation of this writing and erasing of atomic units was in the past only possible after writing, etc. by observing with an STM image. However, this had hardly any meaning in terms of applying the technology to functional memory. Thus, they developed a system that is capable of observing the extraction and accumulation of atoms, which corresponds to writing and erasure, in real time. This method entails constantly monitoring the height between the probe and the test material with the STM tunnel current in a fixed state. This involves the use of a technique in which a feedback loop relating to the height of the probe is set up so that when an atom is extracted, the distance with the probe decreases, and conversely, when an atom is accumulated, that distance increases. If the probe height is monitored, the time and effort of using an STM image to observe every change is not necessary.

However, even though the elemental technologies that can reliably manipulate individual atoms in this way have been established, there are still hurdles to overcome in their application to memory technology. If the holes from extracting atoms are taken to be the one bit units of information, there is the problem that natural holes occur in the crystal, and this causes errors. For this reason, if not individual atoms but several atoms are taken to the unit of one bit, even if there are faults such as natural holes, the atomic manipulations can be done as intended. Thus, this group has demonstrated for the first time that an ASM configuration without noise is possible.

Also, just because the volume in ASM is enormous, there are problems with the practical time it would take to write. Chief Researcher Aono thinks that, "If the STM probe was made into multi-heads of, for example, 100, then high speed application would be possible." This makes ASM based on STM a clear possibility.

Matsushita Develops Repair Technique for Exchanging Bare Chips Mounted with Wire Bonding, Facilitate Cost Reduction in MCM Mounting

94FE0538A Tokyo NIKKEI ELECTRONICS in Japanese 28 Mar 94 pp 169-174

[Article by H. Fujimoto and K. Hatada of Matsushita Electric Industrial Co., Semiconductor Research Center]

[Text] Matsushita Electric Industrial Co. has developed a repair technique for removing LSI bare chips which have been mounted with wire bonding to a resin board and exchanging them. In the past, when a defect occurred in an LSI that was mounted to a resin board by wire bonding, it was difficult to repair. Normally, the entire mounted board would be discarded. Matsushita developed new repair tools which can be installed on commercially available wire bonding equipment. One of the tools cuts the wire and the other one removes the LSI chip. The new tools will be instrumental in reducing the costs of multichip modules (MCM) which consist of several bare chips.

A new repair technique has been developed for multichip modules (MCM), as shown in Figure 1. It consists of removing a defective LSI bare chip from the mounted circuit board and replacing it with a good LSI chip.

The new technique is for mounted circuit boards in which LSI bare chips are connected to an organic resin board by wire bonding. It can also be used to repair COB (chip-on-board) type mounted circuit boards. In both cases, use of the new technique improves yield and reduces cost. Application of the new technique in a mass production line has already been tested and verified.

The new technique involves cutting the bonding wires of the defective chip and removing the defective chip along with all wires. Next, a good chip is installed and connected by wire bonding.

When the repair technique was tested for use with four-chip multichip modules, no new defects were introduced during the repair. A 40-chip, memory controller LSI was repaired using the new technique, to verify absence of residual bonding wire and damage to the mounted circuit board, as well as variation in DC and AC characteristics before and after the repair. No variation occurred in DC and AC characteristics for either the replaced chip or for adjacent chips.

Table 1 shows the composition of the multichip module and the repairconditions used in the test. There were a total of 5120 bonding wires.

Table 1. Multichip Module for Testing the New Repair Technique, and Repair Conditions

Repairs were done on 40 LSI chips, and no problems were observed. There was a total of 5120 bonding wires.	
LSI Chips	No. of chips: 4 (for testing). Chip size: 6.8mm x 6.9mm. No. of pins: 128
Board	Glass/epoxy resin
Die bond resin	Insulating resin (epoxy type)
Bonding wire	Au, 30μm diameter
Wire cutting	Equipment: wire bonder
Cutting load: 100g	
Ultrasonic wave application: none	
Tool application time: 145ns	
Removal of defective chip	Board heating temperature: +150°C
Heating temperature for chip removal tool: +200°C	

Advantage of Wire Bonding Is Lower Cost

Typical LSI chip connection methods used to mount bare chips on circuit boards are the flip chip method and wire bonding method.[2), Note 1)]

Note 1: The TAB method which is used to mount bare chips on tape-like film is regarded to be a packaging method, and is omitted here.

Since the flip chip method can be used to achieve higher mounting density, it can be easily used for large-scale (high pin count, narrow pitch)LSIs. However, because it is necessary to form bumps in the LSI chip electrodes, and because the cost of bump formation and bonding equipment is high, this method is limited to a few applications, such as large computers, thermal printer heads, etc.)

On the other hand, wire bonding provides the least expensive bare chip mounting method. This is because:

(1) there is no need to form bumps on the LSI chip electrodes;

(2) models can be switched by simply changing the data in the wire bonder;

(3) the quality of the connection can be checked visually;

(4) the equipment is not expensive.

This method is most suitable for bare chip mounting of LSI chips having 150 or less input/output pins, and when mounting density is relatively low.

The wire bonding method was originally used to mount LSIs in watches and calculators. More recently it has been used for smaller and more lightweight applications in cellular telephones, pocket pages, and camcorders.

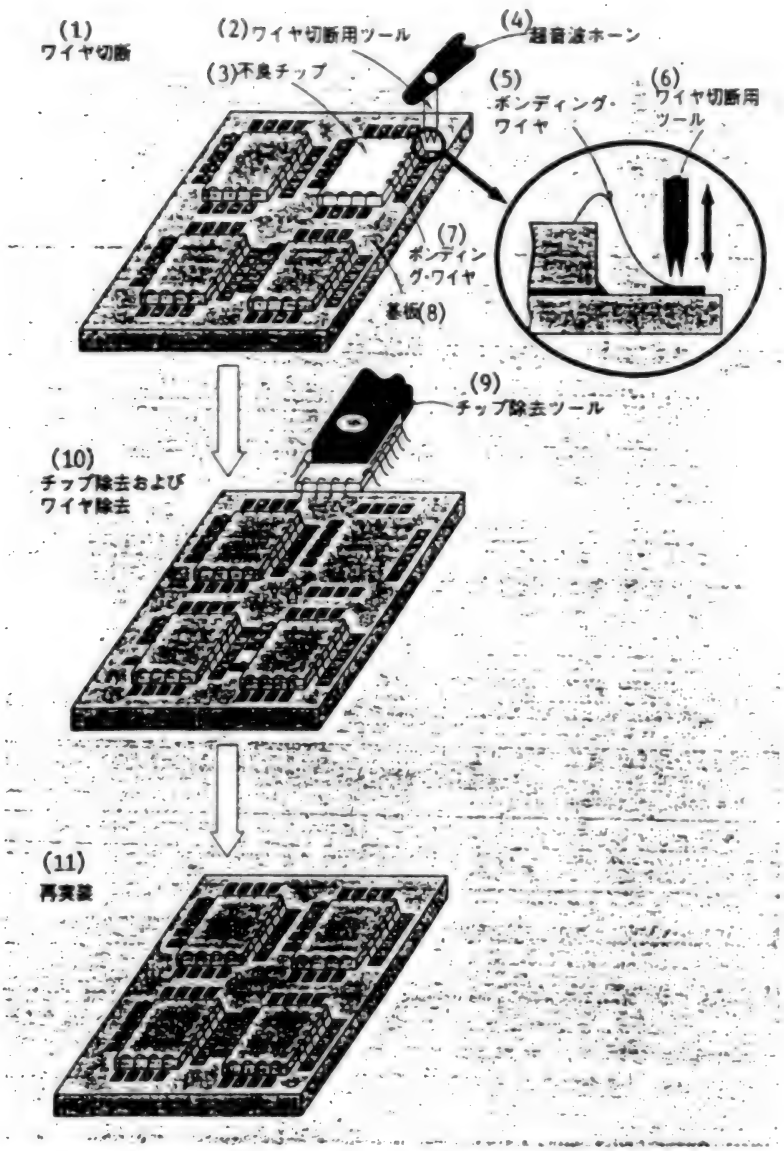


Figure 1. Repair Technique Developed for Use in Wire-Bonded Multichip Modules The bonding wires of defective LSI chips are cut where they connect to the board. Next, the LSI chip is removed together with the bonding wire. Then the good LSI chip is mounted. The tools used for cutting and removing can be attached to commercially sold wire bonding equipment.

Key: 1. Wires cut; 2. Wire cutting tool; 3. Defective chip; 4. Ultrasonic horn; 5. Bonding wire; 6. Wire cutting tool; 7. Bonding wire; 8. Board; 9. Chip removal tool; 10. Chip and wires removed; 11. New chip mounted.

Defective Chips Formerly Discarded Along with Entire Board

The multichip module is being sought as a means of achieving high density mounting in the future. Research and development has recently progressed in this regard, and some companies have implemented this method on a practical basis.

Multichip modules can be roughly divided into two types; those which are intended to improve performance such as in workstations, and those which are intended to achieve smaller size and lightweight characteristics such as in consumer equipment applications.

Since the multichip modules which are designed for lighter weight and smaller size are not intended to

provide better performance, an increase in cost cannot be justified. The cost of multichip modules for consumer equipment should be equal to or less than that for mounting individual LSI packages onto a motherboard.

The high frequency characteristics of bare chips cannot be accurately measured in LSIs. Appropriate tests for high-speed digital LSIs and high-frequency analog ICs will become available after the multichip modules have been built. For this reason, the non-defective rate for multichip modules is a product of the non-defective rate for each individual LSI chip (the AC non-defective rate times the non-defective rate of the mounting process). If there is no means of repairing the multichip module, the non-defective rate is much lower than the non-defective rate of individually packages LSIs. This leads to higher costs.

In order to achieve lower cost multichip modules, it is important to repair defective chips to raise the ultimate non-defective rate.

Repair of bare chips can be done relatively easily if the flip-chip method has been used to solder bumps. Defective chips can be removed by heating and remelting the solder.

However, when wire bonding is used, the connection between the wire and electrode does not melt. Since it is a solid phase connection, the wire cannot be removed from the electrode by heating. This makes it difficult to repair.

For this reason, in the past, defective chips were discarded together with the entire printed circuit board. Therefore, LSIs which have a relatively low operational frequency were used for multichip modules and chip-on-board (COB) applications, and the number of LSI chips was limited to two or three.

Repair Achieved Using Existing Equipment

Figure 2 shows a cross sectional view of a multichip module which has been mounted to a resin board with wire bonding. The repair of this type of MCM was considered.

The following items were taken into consideration when developing the new repair technique:

(1) Since the multichip module requires both lower cost and high density, an inexpensive organic board should be used, with wiring also present in the die bond area of the LSI chip. When removing the defective chip from the board, a method which does not damage the wiring in the die bond area should be used.

(2) In order to raise productivity and reliability, the bonding wires should be able to be removed together with the entire chip. Removing the cut wires one by one takes time, and there is the problem of what to do when one wire is missed.

(3) The replacement chip should be bonded by the same method used for surrounding chips, in order to assure the same level of reliability for all chips.

(4) Automatic repair should be possible using already existing equipment. In other words, the repair should be able to be accomplished using a wire bonder already in existence. Designing a new specialized repair device would result in higher cost, so this is to be avoided.

As described above, it is difficult to remove the bonding wire by heating. Therefore, the wire is first cut on the side of the mounted circuit board. Then, the defective chip is heated to weaken the adhesive strength and to make it possible to remove the chip together with the wires. For this purpose, a wire cutting tool and chip removal tool which can be attached to already existing wire bonding device were developed.

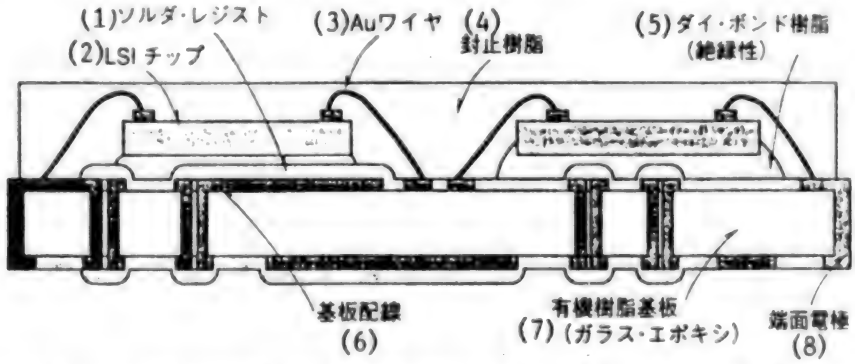


Figure 2. Structure of Multichip Module Used in Development of Repair Technology This is a low-cost multichip module with a glass/epoxy organic resin substrate. To increase the mounting density, wiring was also formed at the bottom of the LSI chip (in the die bond area). The wiring surface is insulated with photosensitive solder resist, and the LSI chip is die-bonded on top of that with insulating die bond resin. For the electrodes on the substrate side, Ni-Au plating was used on 35µm-thick Cu. Ultrasonic thermal compression method with Au wire was used for wire bonding.

Key: 1. Solder resist; 2. LSI chip; 3. Au wire; 4. Sealant resin; 5. Die bond resin (insulating); 6. Substrate wiring; 7. Organic resin board (glass/epoxy); 8. Edge electrode.

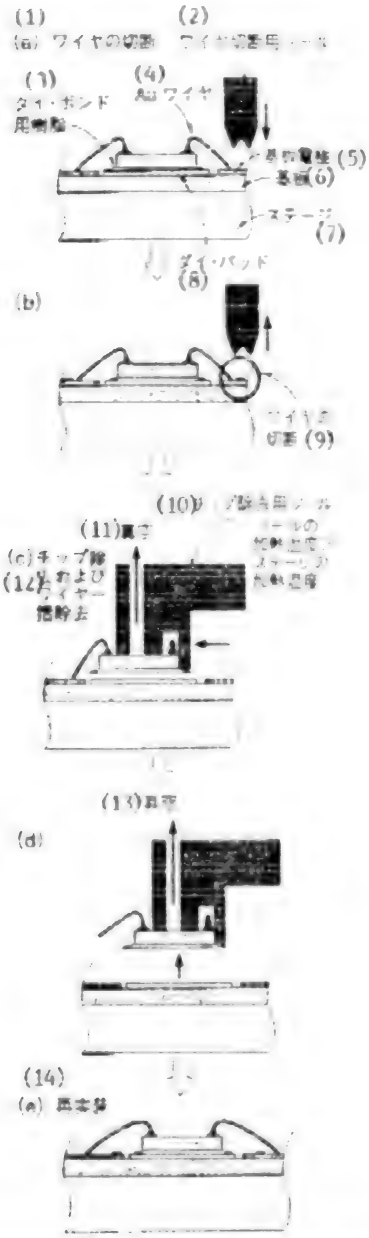


Figure 3. New Repair Process First, the wires are cut one by one using a cylindrical-shaped knife (a)(b). Next, the chip is slid horizontally by the chip removal tool, and the defective LSI chip is peeled from the board (c). The LSI chip is then removed (d). A good LSI chip is then mounted (e).

Key: 1. (a) Wire cutting; 2. Wire cutting tool; 3. Die bond resin; 4. Au wire; 5. Circuit board electrode; 6 Circuit board; 7. Stage; 8. Die pad; 9. Wire cut; 10. Chip removal tool (tool temperature is higher than stage temperature); 11. Vacuum; 12. (c) Chip and wire removed together; 13. Vacuum; 14. (e) Remounting

The new repair process is shown in Figure 3.

Before the repair work is started, the electrical characteristics of modules which have been wire bonded are inspected and defective chips are identified.

The first step in the repair process is to cut the bonding wires of the defective chips one at a time in the area where they are connected to the board, using the wire cutting tool. The external dimensions of the wire cutting tool are the same as those of the Au bowl bonding capillary (a bonding tool). The wire cutting tool can be attached to the ultrasonic horn[2] of a commercially available wire bonder. ([2]*Bonding tool holder. The holder is called a horn because it becomes an ultrasonic oscillator during ultrasonic bonding)*

The tip of the tool has a circular-shaped cutting knife for directional control (see Figure 4). The diameter of the tip area is 200μm. This was determined after taking into consideration the positioning accuracy of the bonded wires, the pressure alignment accuracy of the wire cutting tool, and the processing of residual wires. The tool is lowered directly from above and pressed against the bonding to cut the wires. The area on the board where the wire was cut is pressed against and adhered to the electrode. Figure 5 shows the tensile strength of wires after the wire cutting tool has been pressed against the bonded wire. Two methods were examined with regard to the movement of the wire cutting tool; in one method, the tool is pressed against the bonded wires and then raised directly upward, and in the other method, the tool is pressed against the wires and then moved several microns horizontally before being raised.

For the former method, tensile strength of the wire is 3gf or less, which is about 1/6 the initial value. For the latter method, tensile strength is about 1gf or less, because the wires are completely separated.

In either case, the new wire cutting tool can be used to easily cut the bonded wires. Ultimately, the method in

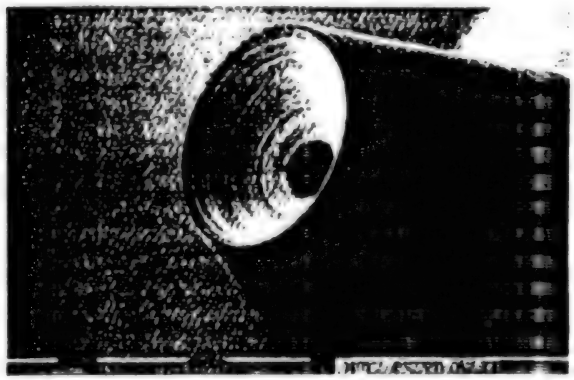


Figure 4. Tip of Wire Cutting Tool The cutting knife is cylindrical and tip diameter is 300μm. This diameter was eventually reduced to 200μm.

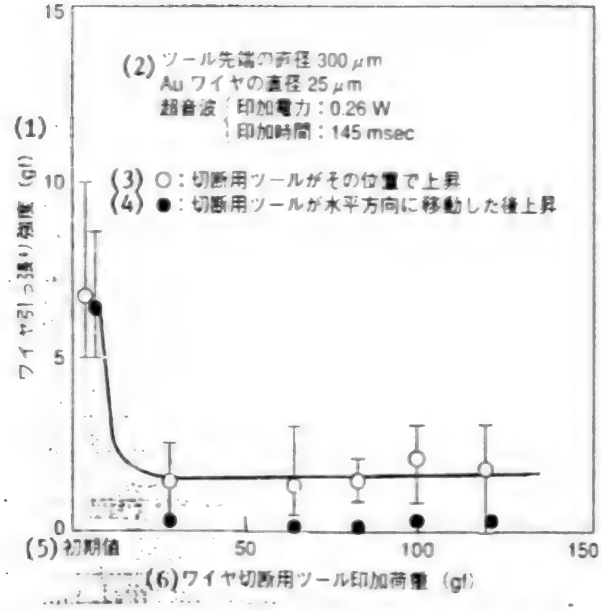


Figure 5. Wire Cutting Load and Tensile Strength of Wire Two methods were compared. In one method, the wire cutting tool is lowered onto the wire and then raised; in the other method, the tool is lowered onto the wire, moved several microns horizontally, and then raised.

Key: 1. Wire tensile strength (gf); 2. Diameter of tool tip: 300μm Diameter of Au wire: 25μm Ultrasonic waves - Power applied: 0.26W Time applied: 145msec; 3. White circle: cutting tool raised directly; 4. Black circle: cutting tool shifted horizontally before raising; 5. Initial value; 6. Wire cutting tool load applied (gf).

which the tool is raised directly from the cutting position was selected because of the shorter cutting time required. It takes 0.1 second to cut a single wire.

Figure 6 shows the connection area on the circuit board after the wire cutting tool has cut the wire. The residual wire is joined to the electrode on the board where the wire was cut. It was confirmed that there is no contact between the residual wires and adjacent electrodes.

Chip Is Heated and then Peeled Away

After the bonding wire is cut, the defective chip is removed from the circuit board. To remove the defective chip, the chip and board are heated, and then shearing force is applied to the chip by the chip removal tool (the chip is slid horizontally and peeled from the board). The correlation between the heating temperature and the shearing strength, and the effects of chip shearing on the MCM substrate, were examined. Three types of die bond resin were evaluated. All three types were commercially available epoxy-type, heat-hardened, insulating resin.

Figure 7 shows the correlation between heating temperature and shearing strength. For all types of die bond resin,

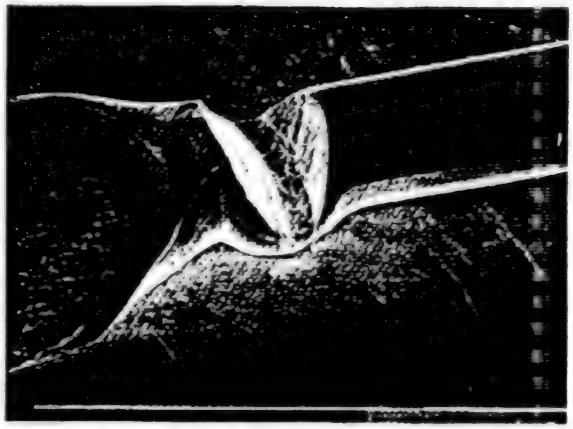


Figure 6. Wire Cut Area

when heating temperature is 150°C or higher, shearing strength decreases to 10-30% of the room temperature value. The chip can then be easily peeled from the board.

However, depending on the combination of solder resist and die bond resin used, in some cases the solder resist may be completely peeled away from the board. It is possible to select the type of die bond resin that can be repaired from among commercially available products (see Figure 7).

All Wire Removed at Same Time

The bonding wires which were cut at the junction to the circuit board are removed at one time while their junction to the chip electrodes remains intact. A chip removal tool which is attached to a wire bonder (see Figures 1 and 3), is used to remove the chip. The torque of an X-Y table is used to apply shearing force to the chip. This process can be easily automated.

After the chip is removed, the die bond resin which remains on the die pad is removed. While the board is still hot, a heat-resistant plastic stick is used to scrape off the residual resin. The scraped-off resin is removed by vacuum suction. The heat-resistant plastic stick is softer than the solder resist. Therefore, the residual resin can easily be removed without damaging the solder resist on the board.

When mounting the good chip, the same die bond and wire bonding conditions that initially used will apply. However, the wire bonding position for the electrode on the board side should be shifted slightly from the first bonding position.

Figure 8 shows the bonding wire after the good chip has been mounted. The wires are cleanly connected to the board. The remnants of the cut wire can be seen on the left side.

Position of Wire Remnants Controlled

If the board is inclined while the bonding wire is cut, the tip of the wire remnant on the board side will rise up

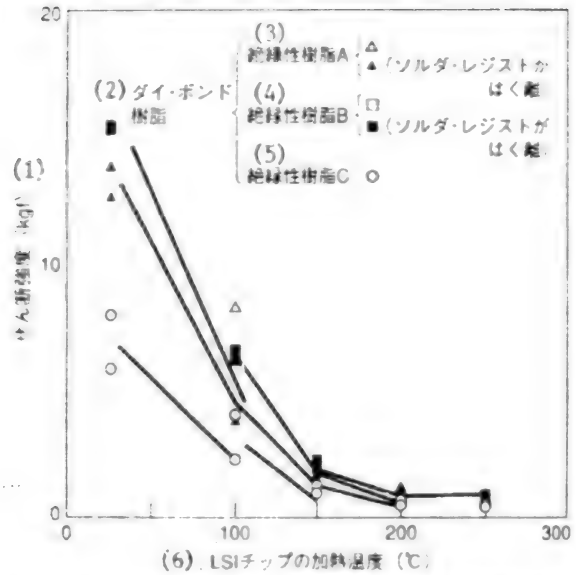


Figure 7. Correlation between Shearing Strength and Temperature of Die Bond Resin The LSI chip measured was 2mm square and die bond was solder resist. Depending on the type of resin used, the solder resist may separate (resin A and resin B). Material which does not separate (resin C) was selected.

Key: 1. Shearing Strength (kgf); 2. Die bond resin; 3. Insulating resin A (black triangle: (solder resist peels away); 4. Insulating resin B (black square: (solder resist peels away); 5. Insulating Resin C O; 6. Temperature applied to LSI chip (°C

when the cut bonding wire is pulled at the same time that the chip is removed. If this happens, the bonding wires of the good chip may touch the remnant bonding wires and come in contact with adjacent wires.

The reason why the tips of remnant wires rise up is because the inclination of the board results in insufficient pressure being applied from the cutting tool knife to the Au wire, and metallic bonding between board electrode and Au is weak. This condition was eliminated by narrowing the size of the cutting tool tip diameter to 200μm and by keeping board inclination to 1/250.

References

1. H. Fujimoto, K. Hatada, M. Umeda: "Development of MCM Repair Technique Using Wire Bonding Method." Research Journal of the Electronic Data Communications Society (Integrated Circuits), ICD 93-156, pp 25-30, Dec 1993.

2. S. Kayama, K. Naruse: VLSI Packaging Technology, pp 228-229, Nikkei BP Co., 1993.

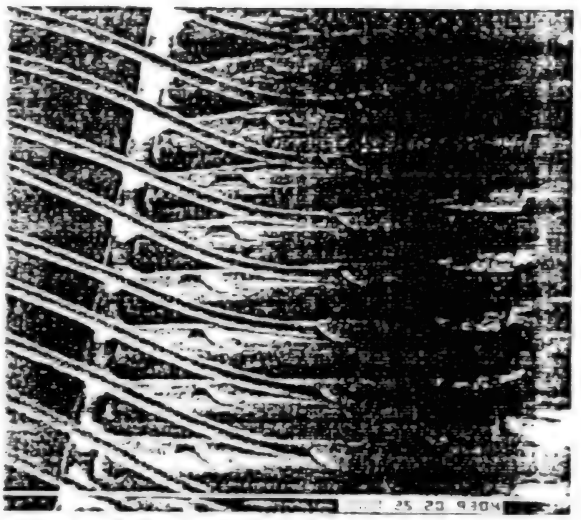


Figure 8. Bonding Wires and Board Connections after Mounting Replacement LSI Chip The wires are neatly connected to the board. Remnants of cut wires can been seen on the left side.

Matsushita Denki Develops New Plasma Etching Technology for 0.3m Application

94FE0443A Tokyo SEMICONDUCTOR WORLD in Japanese Feb 94 p 24

[Text] Matsushita Denki has applied a new high vacuum plasma etching method called lissajous electron plasma (LEP), in the fabrication of aluminum lines, and has confirmed that it is an effective method at the 0.3μm level, which corresponds to the design rule for the 64M DRAM and later generation products.

In the conventional parallel flat-plate type reactive ion etching (RIE) method, etching progresses by sputtering and chemical reaction; but due to inconsistent directivity of ion injection, the design rule has been limited to 0.5μm. In electron cyclotron resonance (ECR) etching and in magnetron etching, plasma density is uneven, so when the aluminum wires being etched reach a length of several millimeters, the electrical changes irradiated from the plasma come together and current flows to the gate oxide film. Problems such as oxide film damage have occurred even in gate oxide films 100 angstroms thick.

The new LEP method consists of applying three high frequency (54.24MHz) voltages which are 120 degrees out of phase relative to each other, to three electrodes positioned at rotational symmetry as shown in Figure 1. This creates a rotational magnetic field and generates plasma. Uniform plasma of $10^{10}/cm^3$ or greater can be generated at a gas pressure of 1Pa.

Matsushita has already applied this LEP method in silicon etching, and high precision/low damage etching results have been achieved. In addition, when the LEP

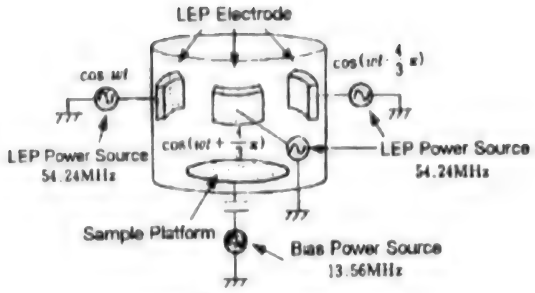


Figure 1. LEP Composition

method was used in the fabrication of subminiature aluminum wires, no damage was observed even in gate oxide film 80 angstroms thick (which corresponds to a DRAM using the 0.3μm design rule) for a 10mm long aluminum wire.

In the past, it has been necessary to insert a protection diode to prevent reverse current flow from the plasma and subsequent damage to the oxide film. However, this is not necessary with the new LEP method. As a result, the LSI design time period can be shortened, and the operating speed of the chip is 10% faster than before due to the elimination of unneeded devices.

Since LEP is performed in a high vacuum environment, ionic directivity is good, and there is no longer a need to use sidewall protective films (high polymer films formed in plasma such as hydrocarbon gas and halocarbon gas). This enables favorable etching of line shapes. In addition, the generation of particulates is suppressed by the sidewall blocking film, and higher yield can be expected for devices.

Hitachi Succeeds in Room-Temperature Operation of Single Electron Memory Opening Way to Realization of 16G DRAM

94FE0445A Tokyo SEMICONDUCTOR WORLD in Japanese Feb 94 p 27

[Text] Hitachi Ltd. has developed a prototype single-electron memory which can store one bit of information in a single electron, and has succeeded in achieving room-temperature operation. The new memory consists of enclosing a single electron in an ultra-small silicon crystal grain; it has been confirmed that once the electron is enclosed, it can be held for more than one month. This opens the way to achieving the 16G DRAM.

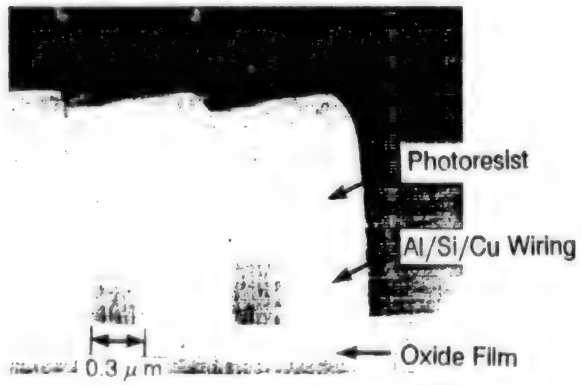


Figure 2. Al Etch Shape by LEP

Semiconductor memories store the information "1" or "0" by means of a capacitor charge. Semiconductor memories which are currently being used on a practical basis require more than 10,000 electrons to store one bit of information. However, the single-electron memory stores one bit of data in a single electron, and therefore has drawn attention as an ultra-high density, ultra-low power consumption power device. However, the information in a single electron is soon erased by heat, so devices which have been developed in the past could only operate in an extremely low temperature environment close to a temperature of absolute 0°K (-273°C). In order to achieve a device which could operate at normal room temperature, it was essential to create an ultra-small structure, 10nm square or less, and to enclose the electron inside.

Hitachi focused on polycrystal silicon (poly-Si), which is an aggregate of subminiature silicon granules. A technique was developed which could form naturally a 10nm square silicon structure without having to use ultrafine fabrication methods. Since the electrons accumulate in the extremely small 10nm area, it was possible to achieve for the first time room temperature operation of the single-electron memory.

To form the device, a gate electrode 0.1μm wide, which controls the current, first is formed on the silicon substrate. A silicon oxide film is then created, on which silicon lines 0.1μm wide and 4nm thick are arranged in a cross formation, corresponding to the drain and source. By using the optimum line thickness and formation temperature, poly-Si in 10nm crystal granules can be formed. The memory operation takes place at the very small junction areas.

The silicon single crystal granules within the polycrystal have various sizes and crystalline structures. When voltage is applied to the gate, electrons flow from crystal grain to crystal grain in the easiest route possible. If additional voltage is applied to the gate at that time, one of the electrons within the flow is expelled, and is captured in a crystal grain outside the flow. Assigning a status of "1" when there is a captured electron and a status of "0" when there is no electron captured, makes it possible to store information.

At this point, when an electron is captured, the flow of electrons through the original route is hindered by the repelling force between electrons, and the current decreases. The information which has been written can be read by detecting the different electrical current values.

The assertion that the electrons are enclosed one by one in the crystal granules can be proven by the fact that

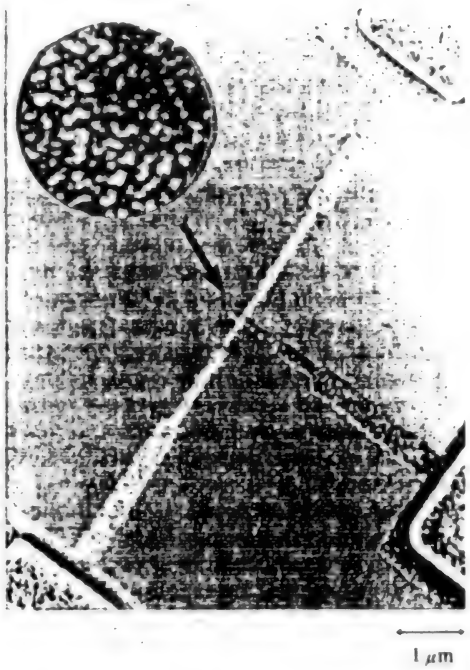


Figure 1. Single-Electron Memory which Operates at Room Temperature (area within circle is enlarged)

when the voltage applied to the gate is gradually increased, the value of the current which flows changes discreetly, and that amount of change corresponds to the energy of one electron.

Toshiba Succeeds in Test Production of MOS Transistor Realizing 0.04μm Gate Length

94FE0444A Tokyo SEMICONDUCTOR WORLD in Japanese Feb 94 p 25

[Text] Toshiba has succeeded in the trial manufacture of a MOS transistor having a gate length of 0.04μm, which corresponds to a memory capacity of 100G or more. Size has been reduced by 40% compared to former types, and operation has been confirmed at room temperature.

The trial manufacture of transistors having gate lengths of 0.1μm (room temperature operation) and 0.07μm (77K, liquid nitrogen temperature operation) had already been announced in the past, but due to tunnel current (leakage current) which occurs in conjunction with smaller sizes, 0.07μm has been the limit for downsizing technology of MOS transistors.

In the development of more highly integrated and faster ICs, a proportional size reduction rule is used, in which the gate length, gate insulating film, source voltage, and impurity concentration vary in a fixed manner. Using this formula, the physical limitation of 0.003μm has been reached for the leakage current of the gate oxide film. There has been no guideline to achieve a gate length of 0.1μm or less. Also, the patterning of gate length smaller than 0.07μm, and the formation of an ultra shallow drain dispersion layer is impossible to achieve using current techniques, so it has been difficult to create a prototype MOS transistor having a gate length smaller than 0.07μm.

In the newly developed MOS transistor, a method has been adopted in which the depth of the dispersion layer is extremely shallow, gate length is shorter, and the transistor is narrower, instead of maintaining a fixed value for the gate insulating film (0.003μm), source voltage (1.5V) and impurity concentration (10^{18}/cm^3 order). An ashing technique which exposes the pattern to excimer laser light has also been developed to achieve uniform pattern size. This enables patterning even for gate lengths of 0.04μm. Although it has been impossible to form an ultra-shallow drain dispersion layer using conventional ion injection methods, by adopting a solid layer dispersion method which creates a dispersion layer from the PSG gate sidewall to fabricate an ultra-shallow drain dispersion layer, Toshiba has been able to form a 0.01μm drain dispersion layer, which is ¼ the former size.

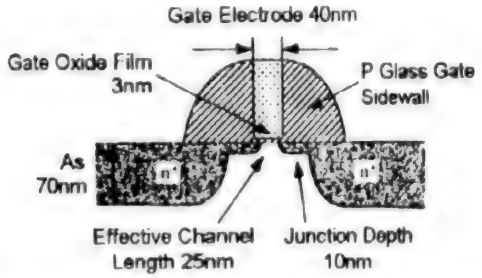


Figure 1. Structure of Prototype MOS Transistor

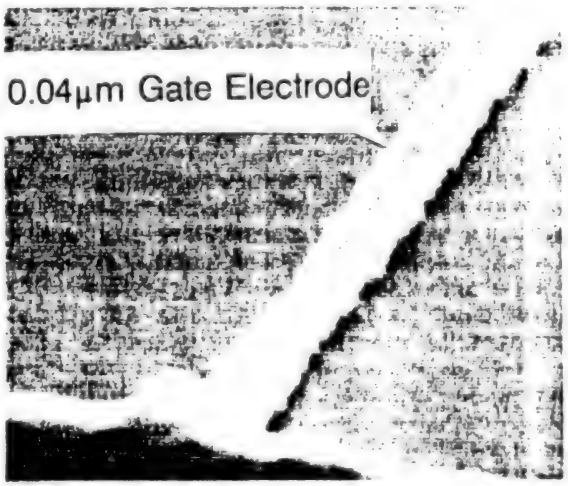


Figure 2. 0.04μm Gate Electrode

Figure 1. Flat Surface Stacked Cell Using High Dielectric Constant Film

capacitors were successfully developed using $SrTiO_3$ and $PbTiO_3$ dielectric thin films. Because of the high temperatures at which those materials were formed in the

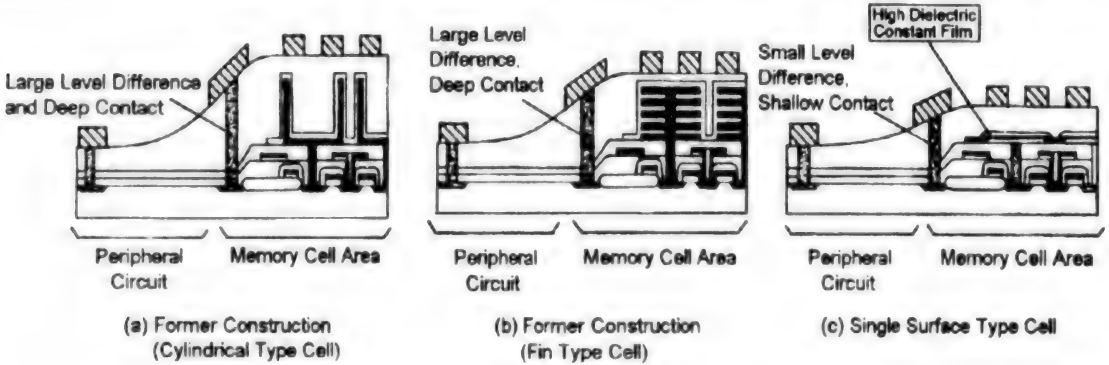


Figure 2. Former Construction and Single Surface Type Stacked Cell

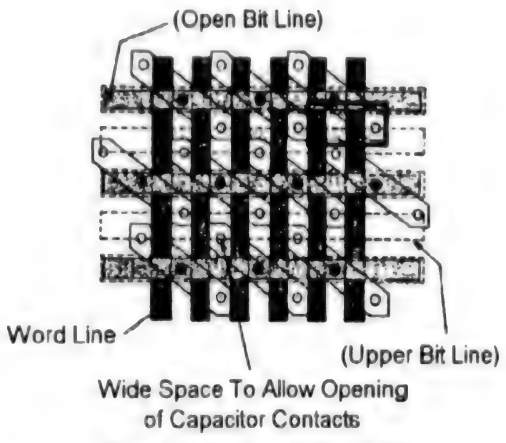


Figure 3. Design of New Cell

past and the difficulty in controlling their composition, lower-temperature sputtering processes with greater precision and suitable for mass production were needed to realize thin films of these materials.

Due to the development of low-temperature sputtering technology (a substrate temperature of about 200°C), $SrTiO_3$ by-pass capacitor films could be formed monolithically on a GaAs IC. Those films exhibited excellent dielectric characteristics up to 3 GHz. A high-precision sputtering process for $PbLaTiO_3$ (PLT) thin films that is suitable for mass production has become possible as a result of process control by means of optical emission spectroscopy and the use of sintered ceramic targets. As pyroelectric thin films for infrared sensors, those films exhibited excellent sensitivity. Furthermore, $PbTiO_3$ thin films are grown epitaxially at low temperatures by ion sputtering and other such advanced techniques, and new developments toward next-generation devices are anticipated.

1. Introduction

With the rapid advances toward higher-performance and smaller-sized information-processing equipment, communications devices, and consumer electronics, the semiconductors and electronic parts that make up those are also becoming smaller, lighter, and more densely integrated. To keep up with those trends, research on the latest thin-film devices and on thin-film technology is thriving. Dielectric thin films, in particular, are attracting attention because of their insulating characteristics, ferroelectricity, pyroelectricity, piezoelectricity, optical characteristics, and mechanical characteristics. There is a wide range of practical applications of dielectric thin films.

A high capacitance in a small area can be obtained with thin-film materials that have a high dielectric constant, e.g., $SrTiO_3$ or (Ba, Sr)TiO_3.[1)-4)] Because those films have good high-frequency characteristics and temperature stability, applications as DRAM capacitors, microwave condensers, and small high-capacitance condensers are expected. As for $PbTiO_3$, PLT, and PZT ferroelectric thin films,[5)-18)] in addition to applications as DRAM capacitors, there is vigorous research on their use as non-volatile memory that utilizes polarization reversal. Furthermore, advancements are also being made in the R&D and practical applications of those films as infrared sensors that utilize the films' pyroelectricity, surface wave devices and piezoelectric sensors that utilize their piezoelectricity, and optical functional devices that utilize their electro-optical characteristics.

For those to be possible, low-temperature thin-film processes that form dielectric thin films with good crystallinity are needed. Although various thin-film formation methods are being studied, there are still numerous elements that should be improved before any of those methods can be practical. The biggest problems now are film fatigue and the decreases in a film's dielectric constant and ferroelectricity as its thickness decreases. Ultimately, new ferroelectric materials with high dielectric constants, and methods of producing those must be established in parallel with the development of semiconductors and electronic parts and their fabrication processes.

In connection with sputtering methods and other physical methods of film formation, we aimed for higher-precision, low-temperature synthesis of dielectric thin films and have strived to achieve better control in the formation process. This article presents two examples of the successful application of dielectric materials: (1) a $SrTiO_3$ thin film for GaAs-MMIC (microwave monolithic IC) capacitors, and (2) a PLT thin film for pyroelectric infrared sensors. The article then discusses the formation of a Pb-system ferroelectric thin film using ion-beam sputtering.

2. Formation of a $SrTiO_3$ Thin Film for a GaAs-MMIC

With the rapid progress toward miniaturization and high-frequency capabilities in communications equipment in recent years, the development of technology for directly forming condensers and inductors on ICs has become an urgent matter. However, IC size is governed by capacitor size because the dielectric constants of the silicon oxides and silicon nitrides used as capacitor insulating films are small, on the order of 3 to 9. For that reason $SrTiO_3$ and (Ba, Sr)TiO_3 are attracting attention as alternative films. The dielectric constants of these materials in bulk are over 200. Near room temperature there is little temperature fluctuation because they exhibit paraelectricity, and decreases in dielectric constant in high-frequency regions are considered be small.

Nevertheless, to use a fine film that has excellent crystallinity, generally the temperature of the substrate must be kept at 400°C or higher. In that case, the IC will be damaged in present-day processes where dielectric films must be formed directly on the IC. As the substrate temperature drops, the crystallinity decreases. However, if a technique of low-temperature formation of films with excellent crystallinity is found, applications of those

materials in amorphous, polycrystalline, and compound-semiconductor devices will become possible.

Here we will discuss a $SrTiO_3$ thin film that we successfully formed at a low temperature of about 200°C on a GaAs-MMIC by means of RF-magnetron sputtering. By adding a DC bias to the substrate, we were able to further improve the characteristics of the $SrTiO_3$thin film.[1)]

We used a general-purpose RF-magnetron sputtering device, as shown in Figure 1, to form the $SrTiO_3$ thin film. To evaluate the plasma state during the film formation, we used plasma optical emission spectroscopy (OES). We observed part of the emitted light about 10 mm from the surface of the substrate by guiding it through an optical fiber. The substrate holder is isolated from the chamber, and the system is structured such that the substrate potential is either floating or a DC bias can be added. The film formation conditions were a substrate temperature of about 200°C; RF power, 2.83 W/cm^2; O_2/Ar gas flow ratio, 0.115; and gas pressure, 4 mTorr. For the substrate we used p-Si(100) on top of which a Pt/Ti multilayer film was deposited at room temperature by means of electron-beam deposition; in this case, the direction of the Pt orientation was (111). For the target we used a 99.99%-purity $SrTiO_3$ ceramic target that was six inches in diameter. The upper electrode (φ 200 μm) for evaluating the electrical characteristics was formed by electron-beam deposition of Ti and Au. The leakage current was measured at an electric field strength of 1 MV/cm, and the dielectric constant was measured at a frequency of 1 kHz. We used X-ray diffraction (XRD) and secondary ion mass spectrometry (SIMS) to evaluate the sample's crystallinity and composition.

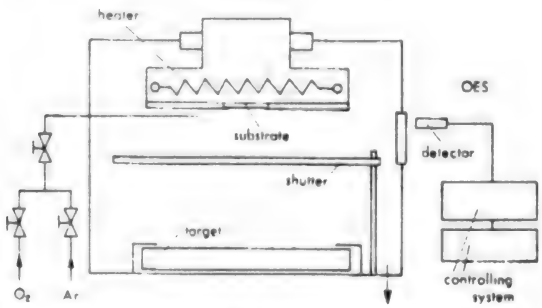


Figure 1. Schematic of RF-Magnetron Sputtering System

The leakage currents and dielectric constants of $SrTiO_3$ thin films fabricated with the substrate potential floating exhibit a conspicuous dependence on the film thickness, as shown in Figure 2. As the film thickness increases, the leakage current drops from 10^{-3} to 10^{-7}A/cm^2, and the dielectric constant increases from 20 to 150. That points to the possibility of obtaining a $SrTiO_3$ thin film that holds up well enough for practical use, if those thickness dependencies can be improved, i.e., if the initial deposition process can be improved. Those leakage current and dielectric constant values are better than the values for a (Ba, Sr)TiO_3 thin film fabricated at the same substrate temperature. Under these kinds of conditions it is highly possible that $SrTiO_3$ thin films are more promising.

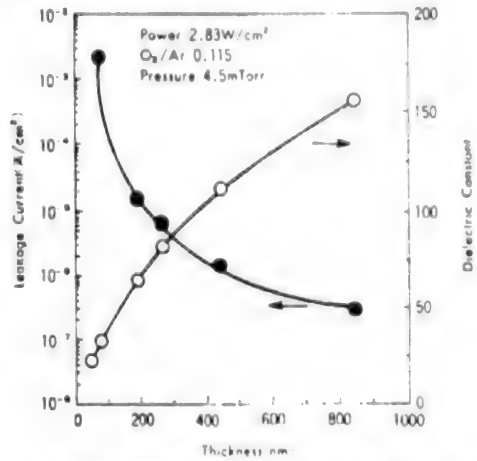


Figure 2. Dependence of Leakage Current, Dielectric Constant on Film Thickness

Thickness dependency is also seen in the crystallinity of the thin film. Figure 3 shows the results of X-ray diffraction. The $SrTiO_3$ thin film formed is weakly polycrystalline, as shown in the inserted diagram of the diffraction pattern, with orientations in the (200) and (110) directions. The diagram shows how the peak diffraction intensities depend on the film thickness; whereas the (110) surface continues to grow along with the film thickness, the growth of the (200) surface becomes saturated. This is thought to be due to curtailment of the growth of the (200) surface, which occurred because of the good epitaxial relationship with the Pt substrate surface, as a result of the growth of a polycrystal with orientation in the weak (110) direction as the growth proceeds.

The affects of impurities and the composition are thought to be one cause of the thickness dependence, but no significant changes in the direction of the film thickness were seen in the SIMS depth distributions of each element. In order to consider the causes of thickness dependence from the viewpoint of the process, we investigated the behavior of the substrate potential. In general, the characteristics of films formed by a plasma process are affected by the plasma state and the related substrate potential. Figure 4 shows the changes in substrate potential measured when a film was formed with the substrate potential floating. Immediately after the deposition started, the substrate potential suddenly rose from about -15 V; after 15 minutes, it stabilized at a value of about +5 V. There is thought to be a possibility that this change in substrate potential and the associated change in the plasma state near the substrate cause the thickness dependence.

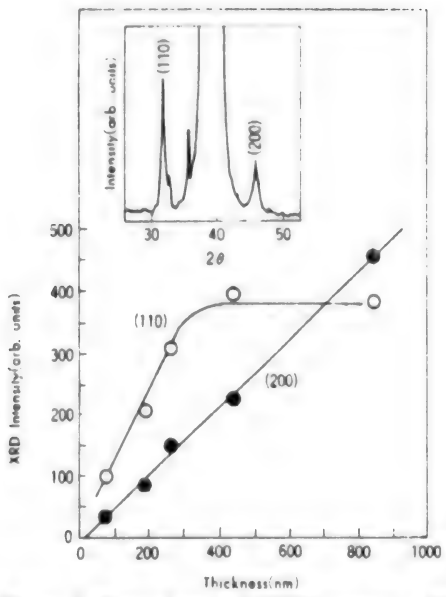


Figure 3. Dependence of XRD Intensity of Sr Ti.0$_3$Films on thickness, and Typical XRD Pattern

As an attempt to improve the initial deposition process, we used a configuration like that shown in the insert of Figure 4 to add a positive DC bias to the substrate. Then we investigated the plasma state during deposition, the structure of the film that was deposited, and the electrical characteristics. We used plasma optical emission spectrometry (OES) to assess the plasma state; the excitations observed were Sr (461 nm), Ti (340 nm), O (777 nm) and O_2^+ (560 nm).

Figure 5 (a) shows how the O_2^+/O and Ti/Sr OES intensity ratios depend on the substrate potential; (b) shows how the (200)/(110) XRD diffraction intensity ratio depends on the substrate potential. Figure 6 shows the substrate potential dependence of the leakage current and dielectric constant of a thin film (3,000 Angstroms thick) formed with the substrate potential biased. Whereas little change is seen in the (200)/(110) XRD diffraction intensity ratio and the dielectric constant, there appears to be a complex dependence of the O_2^+/O and Ti/Sr OES intensity ratios and the leakage current on the substrate potential, indicating that correlation. In this case, as well, no changes were seen in the composition of the thin film, and, although the effects of the substrate bias on the crystallinity and dielectric constant are not very large, the substrate bias noticeably alters the OES and leakage current. The effects of the substrate bias seem to differ around +5 V, but the effects basically depend on the O_2^+/O and Ti/Sr OES intensity ratios and are thought to be due the degree to which the oxidation of the $SrTiO_3$ thin film changes. Practically speaking, by applying a substrate potential of +5 V or more, we can keep the leakage current down to 10^{-6} A¢m^2 or less. Even in the currently ongoing trials in which we introduce ozone into the atmosphere gas, the contributions toward the OES ratios and the leakage current are systematically observed.

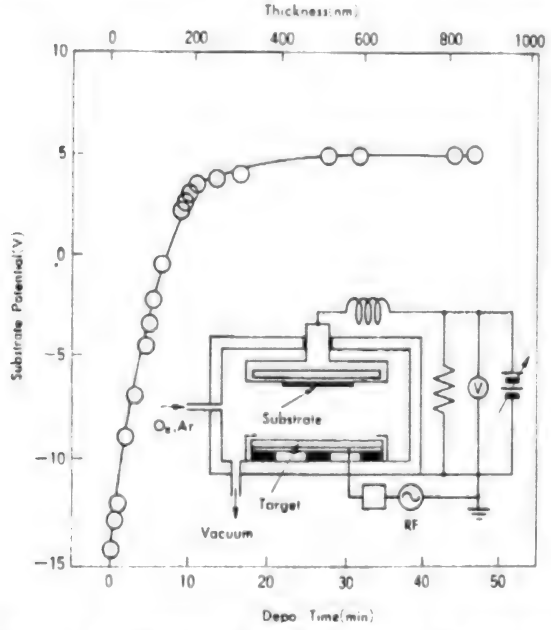


Figure 4. Dependence of Deposition Time on Substrate Potential When a $SrTiO_3$ Film is Formed (Insert Depicts Measurement System)

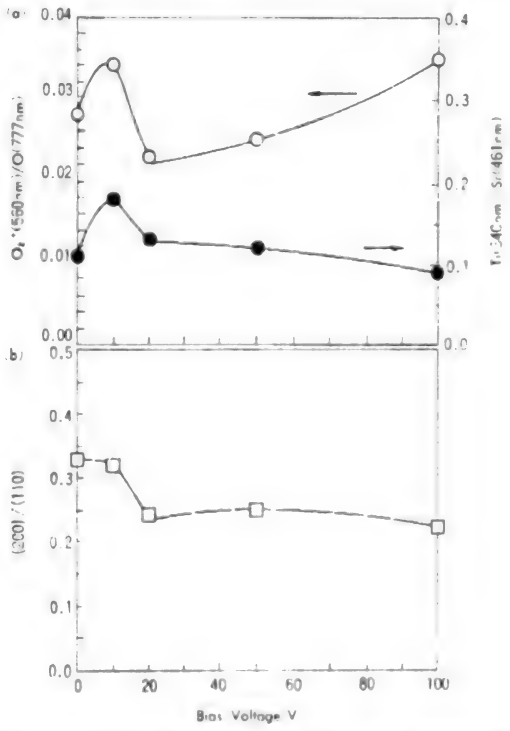


Figure 5. Dependence of O_2^+/O and Ti/Sr OES Intensity Ratios (a), and (200)/(110) XRD Diffraction Intensity Ratio (b) on Substrate Bias Voltage

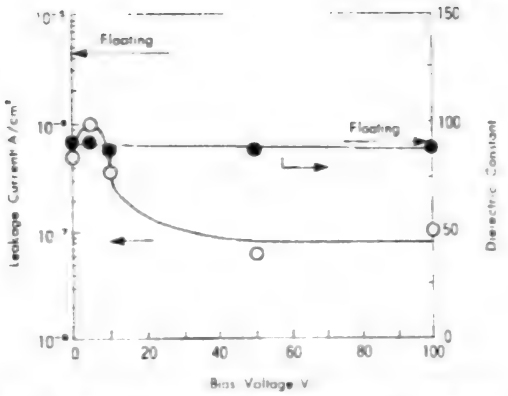


Figure 6. Dependence of Leakage Current, Dielectric Constant of $SrTiO_3$ Film on Substrate Bias Voltage

As discussed above, by sputtering at a low substrate temperature of about 200°C we were able to form on a GaAs-MMIC a $SrTiO_3$ thin film that can withstand practical use; the film exhibited good high-frequency characteristics up to 3 GHz. At that sort of low substrate temperature, the contribution of the energies of the individual particles that take part in the formation process is significant, and controlling those energies is extremely important. Although we could not make the dielectric constant higher by controlling the substrate potential, we were able to reduce the leakage current considerably. Obtaining higher quality $SrTiO_3$ thin films by more sophisticated control of the sputtering process, and further advancements in applications are expected.

3. Formation of PLT Pyroelectric Thin Films for Infrared Sensors

In recent years there have been increasing needs for utilizing infrared image information in consumer products. Here at the Central Research Lab we were the first to succeed in making mass-producible high-performance pyroelectric thin films for infrared sensors, then we incorporated the thin films into an infrared image sensor system for an air conditioner.[11] The pyroelectric material we developed was a $PbTiO_3$-system thin film: $Pb_{0.9}La_{0.1}Ti_{0.975}O_3$ (PLT). The c-axis-orientation PLT thin film has a high pyroelectric coefficient γ, a small dielectric constant ε, and a small heat capacity c_v (the sensitivity of a sensor is generally proportional to $\gamma/\varepsilon c_v$). In comparison with conventional bulk values, the pyroelectric material has about three times more sensitivity.

The Pb-system ferroelectric thin films typified by $PbTiO_3$ (PLT, PZT thin films) could be formed by means of magnetron sputtering, but making those films mass producible necessitated optimization of the essential process. In the past, PLT ceramic powders were often used for the targets. However, depending on the sputtering conditions chosen, the changes in the the target over time were large, and obtaining high-quality thin films with good reproducibility was difficult. We standardized the sputtering process, used plasma optical emission spectrometry as a probe to control the monitoring, and used a homogeneous high-density sintered ceramic for the target. Then we optimized the essential conditions and succeeded in establishing fast and stable sputtering conditions. As a result, high-quality PLT thin films with excellent pyroelectric characteristics were obtained with good reproducibility.[14]

We used the general-purpose sputtering device shown in Figure 1 for a 4-inch-diameter target to carry out studies on making the PLT thin films mass producible. We used a target that was sintered at a high temperature and high pressure and to which an excess of 20% PbO was added. Table 1 gives the details of the sputtering conditions. We used a micro-ammeter to measure the pyroelectric current, and an LCR meter to measure the dielectric constant ε at a frequency of 1 kHz.

Table 1. Sputtering Conditions

Target	$(Pb_{0.9}La_{0.1}Ti_{0.975}O_3)_{0.8}(PbO)_{0.2}$
Substrate	MgO(100)
Substrate temperature (T_S)	540-620°C
Distance between substrate and target	45 mm
RF power	160 W
Sputtering gases	Ar + O_2 (Ar: 8 sccm, O_2: 0-8 sccm)
Gas pressure	0.5 Pa
Deposition rate	1.5-2.3 Angstroms/s
Deposition time	30-45 min

Figure 7 (a) and (b) show how the PLT thin film's Pb/Ti composition ratio and deposition rate depend on the substrate temperature. Changes in the film composition depend on the Pb composition, and the thin film's La/Ti composition ratio matched well with the target composition. Because the Pb or PbO in the film revaporize in large amounts as the substrate temperature rises, the films' Pb/Ti composition ratio and deposition rate decrease. Here, by using OES measurements, we controlled the RF power and sputtering gas flow and optimized the sputtering conditions so that a crystallized PLT thin film with a stoichiometric composition could be obtained at the lowest possible temperature. As shown in Figure 7 (a), when the Ar/O_2 gas flow ratio was one or 10, nicely crystalline PLT thin films with a stoichiometric composition (Pb/Ti = 0.923) were obtained at substrate temperatures ranging from 560-580°C. At lower substrate temperatures, the crystallinity dropped, even when the film composition was stoichiometric. Figure 7 (b) shows a plot of the deposition rate of a PLT thin film formed under the same sputtering conditions using a normal ceramic powder target. In comparison with that target, the deposition rate of a film formed from a sintered ceramic target is much faster. In order to

rapidly form PLT thin films with good reproducibility under optimal sputtering conditions, the ceramic target must be very dense and homogeneous.

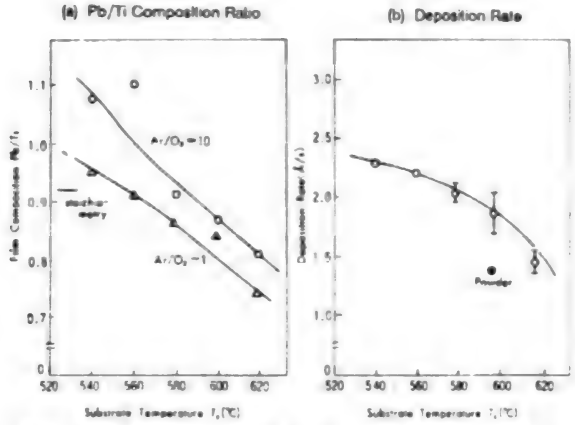


Figure 7. Dependence of PLT Films' Pb/Ti Composition Ratio (a), and Deposition Rate (b) on Substrate Temperature

At substrate temperatures higher than 540°C, PLT thin films formed with Ar/O_2 sputtering gas flow ratios of one and 10 have a perovskite structure, in which c-axis orientation predominates. Figure 8 shows the results of using XRD to evaluate the films' crystallinity. From the substrate temperature dependence of the (001) diffraction peak intensity I(001) in Figure 8 (a), we know that the crystallinity is highest when the substrate temperature is 580°C. At high substrate temperatures I(001) decreases because of the deficit of Pb in the film. The drop in I(001) at lower substrate temperatures indicates that the composition is stoichiometric and that 580°C is the lowest substrate temperature at which a film with good crystallinity can be obtained. In the plot of the full width at half maximum (FWHM) of the (001) diffraction, shown in Figure 8 (b), a minimum value of 0.2° for the FWHM is obtained, so we know that the film is homogeneous and has good crystallinity. From the c-axis orientation ratio α (α = I(001)/(I(001) + I(100))), we see that close to a 100% orientation ratio is obtained. However, in comparison to when the Ar/O_2 sputtering gas flow ratio is one, films formed with the Ar/O_2 sputtering gas flow ratio equal to 10 show better values over a wide range of substrate temperatures. Thus, we know that the Ar/O_2 sputtering gas flow ratio is one of the most important parameters for forming high-quality PLT thin films with good reproducibility.

We carried out OES measurements for the purpose of clarifying the relationship between the PLT thin-film characteristics described above and the sputtering conditions. Watching the excitation species Pb^* (406 nm) and Ti^* (396 nm) is sufficient; changes in the other excitation species, Ar^* (707 nm) and O_2^* (777 nm), mimic changes in the Pb^*

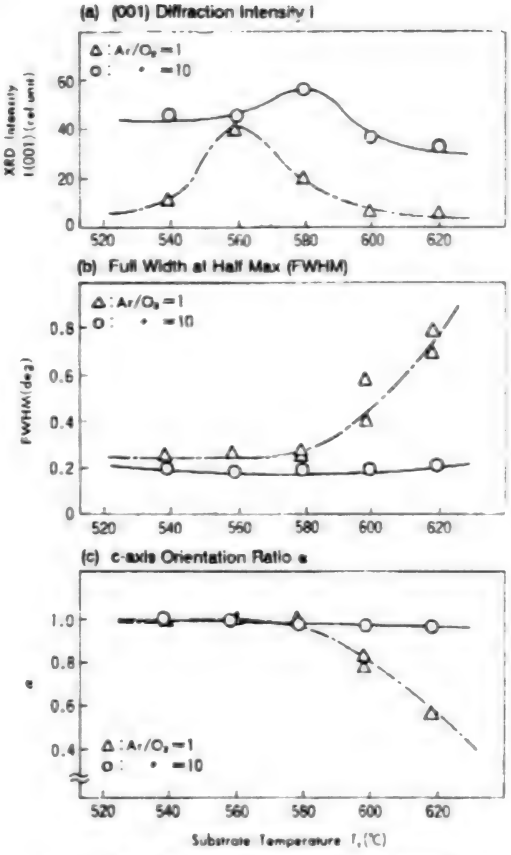


Figure 8. Results of XRD of PLT Films

and Ti^*. Figure 9 (a) shows how the emission intensities of Pb^* and Ti^* depend on the Ar/O_2 sputtering gas flow ratio. As the Ar/O_2 ratio increases, the Pb^* intensity increases conspicuously, but the Ti^* intensity increases only mildly. That is thought to be due to the difference in the sputtering rates of Pb and Ti atoms with respect to the Ar/O_2 ratio. With a high Ar/O_2 ratio, an increase in the ratio of the numbers of Pb and Ti atoms flying off from the target to the substrate is inferred; that does not contradict the trend shown in Figure 7 (a). When the Ar/O_2 ratio was increased from one to 10, the Pb^*/Ti^* emission intensity ratio increased up to the range of 1.8 to 4.5. This Pb^*/Ti^* emission intensity ratio is an effective parameter in the standardization and control of the PLT thin-film formation process, and, like the Ar/O_2 ratio, it also becomes a function of the RF power and the total gas pressure. As shown in Figure 10, the (001) peak's FWHM is also a function of the Pb^*/Ti^* emission intensity ratio when the Ar/O_2 ratio is 10. Controlling this Pb^*/Ti^* emission intensity ratio to be in the range from three to five becomes important in forming PLT thin films with good crystallinity. This method of using OES could be applied in in-situ process monitoring, and the stability of the process we developed was confirmed over a long time period.

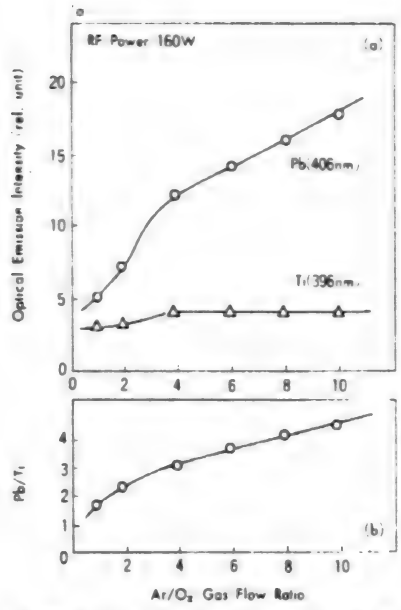


Figure 9. Emission Intensities of Pb^* and Ti^* (a), and Dependence of Pb^*/Ti^* Ratio on Sputtering Gas Flow Ratio

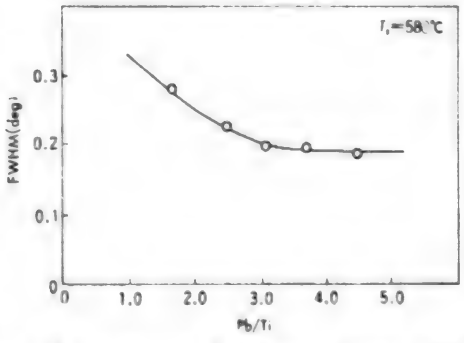


Figure 10. Dependence of Half-Value Width (FWHM) on OES Intensity Ratio

Figure 11 shows the changes in the pyroelectric coefficient γ and the dielectric constant ε with respect to the substrate temperature for 2.0-to 2.5-μm-thick PLT thin films formed with the Ar/O_2 ratio equal to 10. The films formed with a substrate temperature of 580°C, which had the best crystallinity, exhibited a high pyroelectric coefficient of 4.2×10^{-8} C/cm^2 and quite a low dielectric constant of 290. That value of pyroelectric coefficient was about twice as large as that for a $PbTiO_3$ ceramic.

Then, by optimizing the RF magnetron sputtering method, we could form high-quality pyroelectric PLT thin films with good reproducibility. By introducing a sintered ceramic target and controlling the Pb^*/Ti^* emission intensity ratio, we could obtain PLT thin films with

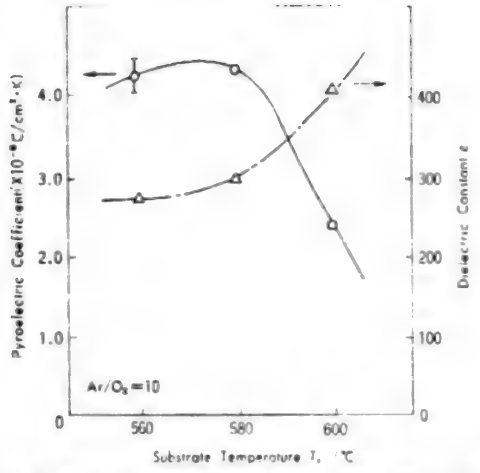


Figure 11. Dependence of PLT Thin Film Pyroelectric Coefficient and Dielectric Constant on Substrate Temperature

good crystallinity and a high c-axis orientation ratio with a high deposition rate of 2 Angstroms/s. These techniques established in this experiment were efficiently developed into a large-area sputtering system for the mass production of pyroelectric PLT thin films.

4. Using Ion-Beam Sputtering

Formation of Pb-System Ferroelectric Thin Films

As discussed in the previous two sections, the road continues to open up for applications of sputtering in connection with $SrTiO_3$ and PLT thin films. However, more effort towards further advancements in the formation process must be made. We intend to seek after thinner, higher-quality dielectric thin films that can be formed at lower temperatures. Here we will describe our attempts to form more advanced Pb-system dielectric thin films using multi-ion sputtering.[15),16)] Despite the weak points of this method—the equipment is expensive and the deposition rate is slow—the film composition can be varied freely, and thin films can be formed in a high vacuum without the damage due to plasma. There is also the possibility that this method can be used to form low-temperature thin films with good crystallinity. Until now, Pb-system ferroelectric thin films required a substrate temperature of 600°C or higher, and good films less than 1,000 Angstroms thick could not be obtained. In our research, however, we were able to form at temperatures as low as 400°C thin films with thicknesses of 1,000 Angstroms or less that exhibit excellent ferroelectricity and good crystallinity.

Figure 12 is a conceptual diagram of the multi-ion sputtering device. We used Pb, La, Zr, and Ti metal targets, and irradiated them with Ar ion beams accelerated to 1,100 V from ion sources pointing toward each target. Table 2 shows the sputtering conditions. For the

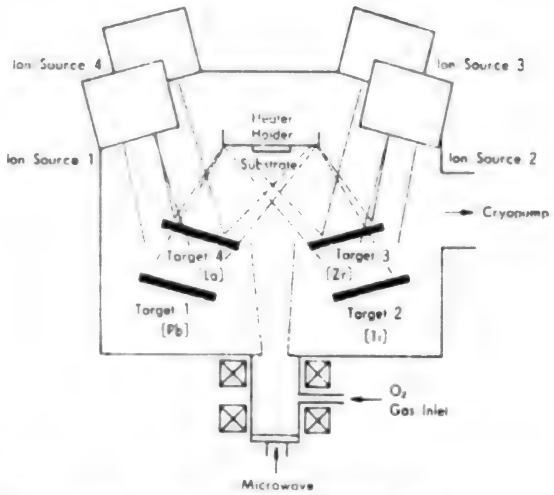


Figure 12. Schematic of Multi-Ion Beam Sputtering System

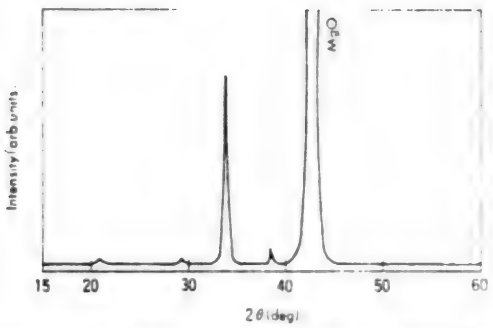


Figure 13. XRD Pattern of PZT Film on MgO Substrate (Without PLT Buffer Layer)

substrates we used (100)MgO; for electrode portions, we used (100)Pt/MgO and (111)Pt/Ti/SiO_2/Si, which vapor-deposited about 700 Angstroms of Pt onto the surface. We controlled the film composition by varying the current of the Ar ion beams, introduced oxygen gas near the substrate, and carried out reactive film formation in an oxygen atmosphere.

Table 2. Sputtering Conditions

Substrates	(100)MgO, (100)Pt/MgO, (111)Pt/Ti/SiO_2/Si
Substrate temperature	415°C
Targets	Pb, La, Zr, and Ti metals (3-inch)
Sputtering gases	Ar: 1-2 x 10^{-4} Torr, O_2: 1 x 10^{-4} Torr
Ion source voltage	1,100 V
Current	Pb: 6.0-12 mA; Zr, Ti: 12-15 mA; La: 4.0 mA
Deposition rate	7.5 Angstroms/s

PLT and $PbTiO_3$ thin films with very high crystallinity could be obtained by simultaneously sputtering Pb, Ti, and La targets with substrate temperatures of 415°C or higher. The orientations of the thin films reflect an epitaxial relationship with the substrate: on the (100)MgO and (100)Pt/MgO substrates, the films exhibited (001) orientation, i.e., c-axis orientation; on the (111)Pt/Ti/SiO_2/Si substrate, (111) orientation.

PZT thin films, however, are difficult to form under the same conditions if the substrate temperature is raised a certain amount. As shown in the XRD pattern of Figure 13, a strong peak is seen near $2\theta = 34°$, which is inferred to be the diffraction due to the pyrochlora phase or to ZrO_2. This trend is more conspicuous with larger amounts of Zr, and the Pb in the film formed at that time exhibited a tendency to drastically decrease. So, before depositing PZT thin films, we formed very thin PLT buffer layers of about 50 Angstroms on the substrates, then sputtered Pb, Zr, and Ti targets and formed PZT films. At a deposition rate of about 7.5 Angstroms/min, PZT thin films were formed with thicknesses ranging from 600 to 1,800 Angstroms.

Figure 14 shows XRD patterns of PZT films (Zr/Ti = 50/50) formed on PLT buffer layers at a substrate temperature of 415°C. Like $PbTiO_3$ and PLT thin films, perovskite-type PZT thin films with all c-axis orientation were formed on MgO and Pt/MgO substrates; on Pt/Ti/SiO_2/Si, the films were predominantly orientated in the (111) direction. The film thicknesses varied between 600 and 1,800 Angstroms, but no significant changes in crystallinity due to this range of film thicknesses were seen. Almost the same result was obtained in connection with the thickness of the PLT layer, even when it was about 10 Angstroms. It is thought that a PZT thin film can easily be grown epitaxially if beforehand a perovskite layer without any Zr is formed.[17),18)] Another factor in being able to synthesize a nicely crystalline PZT thin film at a low substrate temperature is the presence of sputter particles that have relatively high energies, which is a special characteristic of ion-beam sputtering.

Figure 15 shows TEM images of PZT thin films that were formed on Pt/MgO and Pt/Ti/SiO_2/Si substrates. In both, clear grid images are seen, and we know that the PZT film growth from the substrate is entirely epitaxial. We used a Soya-Towa [transliterated] circuit to investigate the ferroelectric characteristics of the films. Figure 16 (a) and (b) are the P-E hysteresis curves of 630-Angstrom-thick PZT thin films formed on Pt/MgO and Pt/Ti/SiO_2/Si substrates with a 50/50 Zr/Ti composition ratio. Despite the thinness of the films, they exhibit good ferroelectric characteristics. The residual polarization P_r of the film on the Pt/MgO substrate was 34 $\mu C/cm^2$, and the resistive electric field E_c was 240 kV/cm. The P_r of the film on the Pt/Ti/SiO_2/Si substrate was 16 $\mu C/cm^2$, and the E_c was 200 kV/cm. The dielectric constant

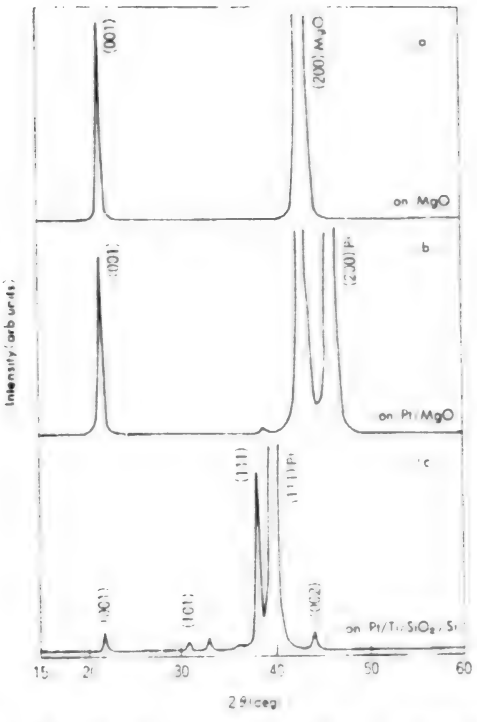
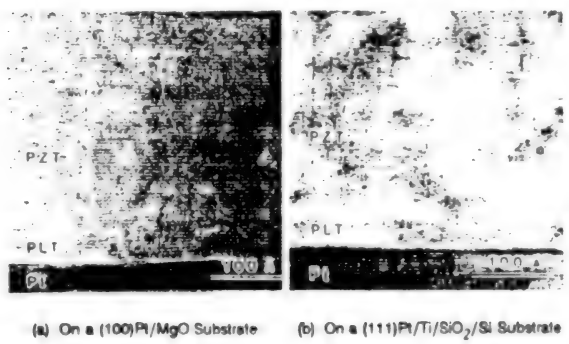


Figure 14. XRD Patterns of PZT Films on PLT Buffer Layers

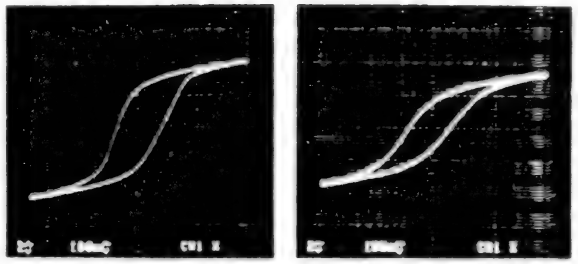


(a) On a (100)Pt/MgO Substrate (b) On a (111)Pt/Ti/SiO_2/Si Substrate

Figure 15. TEM Images of PZT Films

measured at a frequency of 1 kHz stayed high, between 500 and 800, even in such extremely thin films.

Using multi-ion-beam sputtering, we fabricated Pb-system ferroelectric thin films at a low substrate temperature of 415°C. Even films as thin as 600 Angstroms showed good ferroelectric characteristics and had a high dielectric constant. Based on the knowledge gained, we would like to work toward further advancements in Pb-system ferroelectric materials and the processes for forming those. Incidentally, the research described here



(a) On a (100)Pt/MgO Substrate (b) On a (111)Pt/Ti/SiO_2/Si Substrate

Figure 16. P-E Hysteresis Curves of PZT Films

is a part of the "Advanced Chemical Processing Technology R&D" based on the Industrial Technology R&D System of MITI's Agency of Industrial Science and Technology (AIST). This research was brought together by projects commissioned to the Advanced Chemical Processing Technology Research Association (ACTA) by the New Energy and Industrial Technology Development Organization (NEDO).

5. Conclusion

We were able to develop practical-level $SrTiO_3$ and $PbTiO_3$ thin films using sputtering methods. We can say that our basic ideas about going after thinner, higher-quality films formed at lower temperatures, and a competitive attitude toward device development using dielectric thin films have born fruit. We hope that future developments in thin-film technology will bring about further advancements toward next-generation devices using even better dielectric thin films.

Documents Referenced

1. H. Shinriki, et al.: IEEE Trans. Electron. Devices 38, p 455 (1991).

2. S. Yamamichi, et al.: Jpn. J. Appl. Phys. 30, p 2193 (1991).

3. T. Sakuma, et al.: Appl. Phys. Lett. 57, p 2431 (1990).

4. M. Shibuta, et al.: Jpn. J. Appl. Phys. 32, p L350 (1993).

5. K. Iijima, et al.: Jpn. J. Appl. Phys. 30, p 2149 (1991).

6. S.T. Liu: Ferroelectrics 10, p 83 (1976).

7. K. Iijima, et al.: Jpn. J. Appl. Phys. 60, p 361 (1986).

8. R. Takayama, et al.: J. Appl. Phys. 61, p 411 (1987).

9. R. Takayama, et al.: J. Appl. Phys. 63, p 5868 (1988).

10. K. Iijima, et al.: J. Appl. Phys. 60, p 2914 (1986).

11. R. Takayama, et al.: National Tech. Rept. 39, p 122 (1993).

12. T. Ogawa, et al.: Jpn. J. Appl. Phys. 28, p 11 (1989).

13. S. Ibuki, et al.: J. Appl. Phys. 29, p 532 (1990).

14. T. Kamada, et al.: J. Appl. Phys., to be published.

15. S.B. Krupanidhi, et al.: J. Appl. Phys. 71, p 376 (1992).

16. M.S. Ameen, et al.: MRS Proc. 200, p 65 (1990).

17. V. Adachi, et al.: IEEE Trans. UFFC 38, p 645 (1991).

18. K. Kashihara, et al.: Preliminary manuscripts from the 53rd meeting of the Applied Physics Society, 16p-ZV-13, Fall 1992.

Control of Natural Oxidation Film in Miniature Contact Hole Bottoms

94FE0440A Tokyo SEMICONDUCTOR WORLD in Japanese Jan 94 pp 64-67

[Article by Nakamori and Aota of the NEC ULSI Device Development Laboratory]

[Text]

Introduction

In conjunction with the downsizing of LSIs, contact hole diameter has decreased and aspect ratio has increased. Contact holes are 0.2μm and less in the 256M DRAM currently being developed by various companies, and aspect ratio is 5 or greater. The control of the Si surface following dry etching is becoming an important issue. The authors set out to clarify the correlation between the natural oxide film formed on the damage layer after dry etching and contact resistance, the control of the damage layer, and the natural oxide film formed on top of it; and to optimize the natural oxide film processing process for contact hole bottoms.

Experimental Method

Figure 1 shows an outline of the experiment. An oxide film which has been etched and contains contact holes, and one which has an Si surface without patterns, were used as samples. Processing was performed as shown in Figure 1 after contact etching and after CVD oxide film etching. The objectives of each of these processes are discussed below.

- O_2 Plasma Processing: Elimination of the carbon polymer layer which accumulates on the surface after dry etching is performed
- Sulfuric Acid/Hydrogen Peroxide Cleansing: Elimination of organic particles and metallic contaminants
- Chemical Dry Etching (CDE): Elimination of the dry etching damaged layer
- Ammonia/Hydrogen Peroxide Cleansing: Elimination of particles
- Hydrofluoric Acid Processing: Elimination of natural oxide film

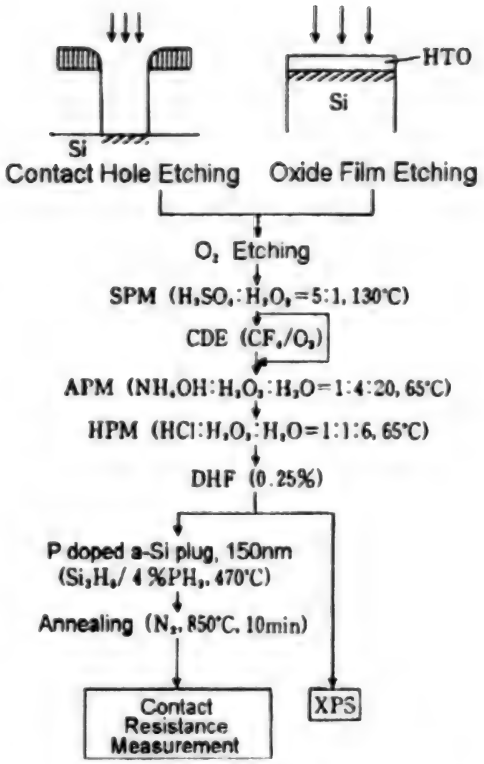


Figure 1. Flow of Sample Production

For the sample with contact holes, P-doping and a-Si embedding were performed and then contact resistance was measured. For the sample which did not contain circuit patterns in the Si surface, the surface composition was analyzed by XPS after each process. The Si surface without patterns simulated the contact hole bottom Si surface condition.

Results of Experiment

Figure 2 shows the variation in surface composition as observed by XPS for each of the processes following dry etching. There is a large decrease in carbon and fluorine after O_2 plasma processing. Regardless of whether or not chemical dry etching has been performed, after ammonia/hydrogen peroxide cleansing, oxygen component decreases slightly and Si increases. This indicates that the surface oxide film has been etched by the ammonia/hydrogen peroxide cleansing. When the hydrofluoric acid process is performed, the oxygen component decreases on surfaces which have been CDE processed, and Si increases. This indicates that the surface is hydrophobic. For surfaces which are not chemical dry-etched, an oxygen component of about 30% was observed regardless of whether or not the hydrofluoric acid treatment was performed. This indicates that the surface is hydrophilic. If the oxide film is not removed following hydrofluoric acid treatment, it is feared that this will affect the contact resistance. For this reason, a

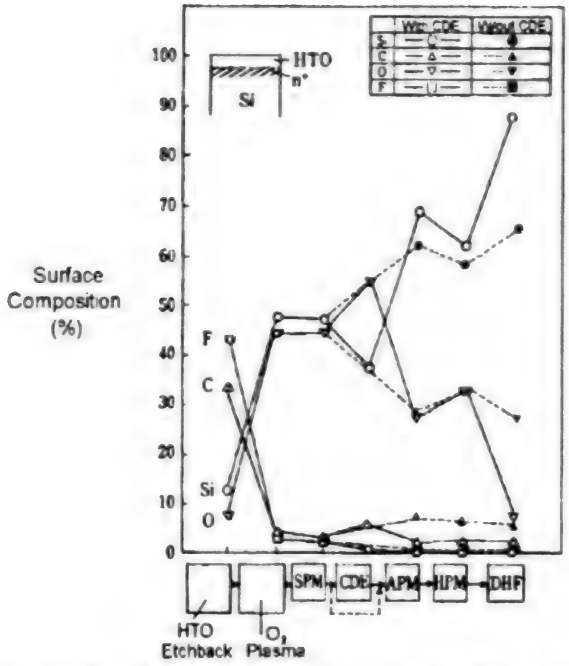


Figure 2. Variation in Surface Composition after Each Process (XPS Analysis)

contact chain was created with contact holes on n+ Si which had undergone the same processing, and contact resistance was evaluated.

Figure 3 shows the correlation between contact resistance and contact hole diameter. Contact resistance decreases by about half when CDE is performed, as compared to when it is not performed. This corresponds to the variation in oxygen content as observed by XPS analysis.

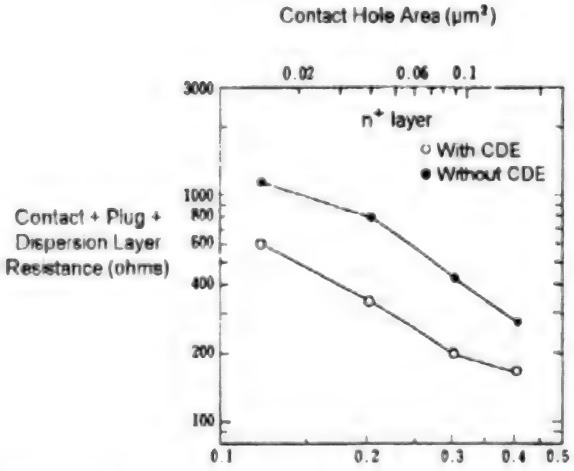


Figure 3. Correlation Between Contact Resistance and Contact Hole Diameter

From the above results, it is surmised that oxide film is present on contact hole bottoms when CDE is not performed, and that this increases the contact resistance.

Next, XPS was used to analyze the Si(2p) spectrum in conjunction with the film properties of this oxide film.

Figure 4 shows the Si(2p) spectrum after dry etching and the various processes were performed. As mentioned above, after O_2 plasma processing, the carbon and fluorine content on the Si surface is minimal, so the chemical shift of the spectrum is thought to be caused chiefly by Si oxide material. On the surface which was not CDE processed, Si^{2+}, Si^{3+}, and other suboxides were observed in addition to the Si^{4+} after ammonia/hydrogen peroxide cleansing, after hydrochloric acid/hydrogen peroxide cleansing, and after hydrofluoric acid treatment were performed. On the other hand, for the surface which was CDE processed, the suboxide peak in the spectrum was smaller after ammonia/hydrogen peroxide cleansing and after hydrochloric acid/hydrogen peroxide cleansing were performed. For this surface, if the hydrofluoric acid treatment is performed, the Si^{1+} which is observed on other oxide peaks is not present, indicating that Si^{2+} and Si^{3+} oxide film is removed.

Figure 5 shows the changes in the sum of Si^{2+} and Si^{3+} suboxide peak intensity attributed to various processes. The sum of Si^{2+} and Si^{3+} suboxide peak intensity differs greatly between the surfaces which have been CDE processed and those which have not.

Figure 6 shows surface models for the correlation between presence of suboxides and CDE with regard to the elimination oxide films following hydrofluoric acid treatment.

On surfaces which were not CDE processed, Si^{4+} is present in addition to Si^{2+} and Si^{3+} suboxides following hydrofluoric acid treatment. In oxide films which are rich in suboxides, Si-Si bonds are present within the oxide film. This occurs for the following reason. Si-Si bonds are present in the suboxide, and these bonds cannot be broken by hydrofluoric acid. Even if the Si^{4+} on the surface is eliminated by the hydrofluoric acid, if Si-Si bonds appear on the surface, the etching progression stops. For this reason, even if there are Si oxygen bonds present further inside than the Si-Si bond, they cannot be broken by hydrofluoric acid, and the suboxides and Si^{4+} which is present inside cannot dissolve. For this type of suboxide, oxygen disperses in the silicon, whose crystalline properties are disrupted by dry etching during O_2 plasma treatment of wet processing, and the oxide film which is formed is imperfect. This forms only when the treatment is done on the dry etching damaged layer. On the other hand, on surfaces which have been chemical dry etched, the damaged layer is removed. On this surface, natural oxide film which does not have suboxides is formed after processing, and this can easily be removed by hydrofluoric acid treatment.

Figure 7 shows a model of the variation in contact holes attributed to various processes after dry etching, in view

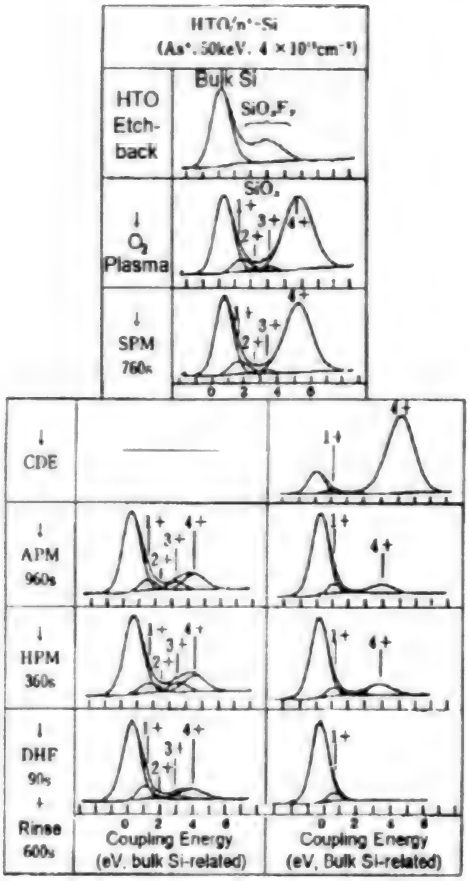


Figure 4. Variation in Si(2p) Spectrum after Each Process (XPS Analysis)

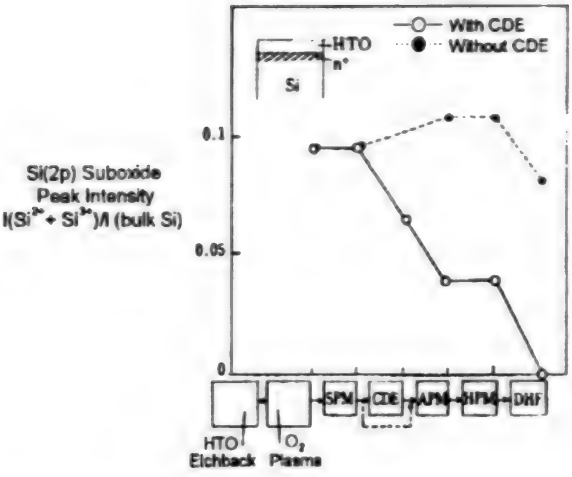


Figure 5. Variation in Si^{2+} and Si^{3+} Peaks after Each Process (XPS Analysis)

of the above results. After dry etching is performed, a dry etching damaged layer and carbon polymer layer are formed on the Si surface. If this carbon polymer layer is removed by O_2 plasma treatment and sulfuric acid/hydrogen peroxide cleansing, the surface becomes suboxide rich. The dry etching damaged layer is removed by performing chemical dry etching. By removing the dry etch damaged layer, a natural oxide film forms after wet cleansing is performed, but the amount of suboxide contained in this natural oxide film is miniscule. On surfaces which have not been chemical dry etched, the dry etch damaged layer is still present, so a suboxide rich natural oxide film remains even after wet cleansing is performed. After hydrofluoric acid treatment, the natural oxide film containing trace amounts of suboxide is removed from CDE processed surfaces by hydrofluoric acid treatment, and low contact resistance can be achieved by embedding plugs in this surface. However, since the suboxide-rich natural oxide film cannot be removed, contact resistance will increase when plugs are embedded in this surface.

Conclusion

From the above, the increase in contact resistance is caused by the formation of a suboxide-rich oxide film on the silicon surface following dry etching, and this film cannot be removed by hydrofluoric acid treatment.

In addition, it has become essential to use chemical dry etching to achieve lower contact resistance. In this way, the dry etch damaged layer is removed, so even when wet processing is done, an oxide film having little suboxide is formed. This can be easily removed by hydrofluoric acid treatment, so a low resistance contact can be achieved. The contact processes described here can be used in the fabrication of 256M DRAMs, which require low-resistance contacts.

References

1. M. Sekine, et al.: Extended Abstracts of the 1992 International Conference on SSDM, Tsukuba (1992) p. 184.

2. N. Aoto, et al.: Extended Abstracts of the 1993 International Conference on SSDM, Makuhari (1993) p. 101.

3. Nakamore, et al: Proceedings of the 54th Conference of the Applied Physics Society, 29a-ZE-3 (1993) p. 765.

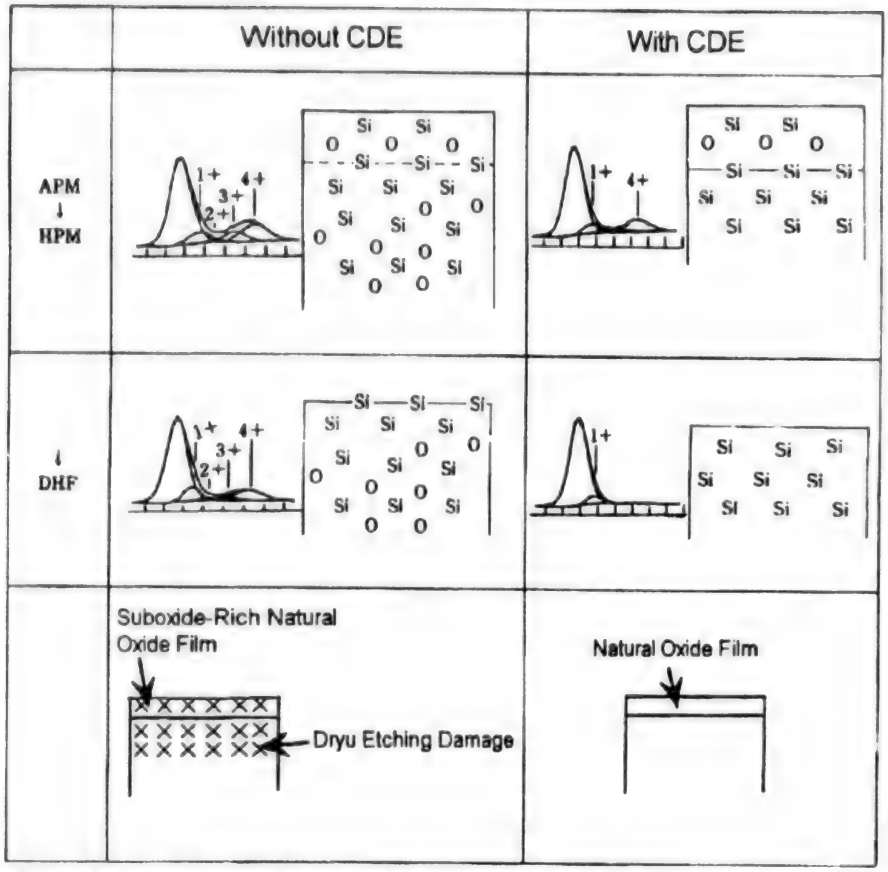


Figure 6. Surface Models after Wet Processing Relative to Chemical Dry Etching

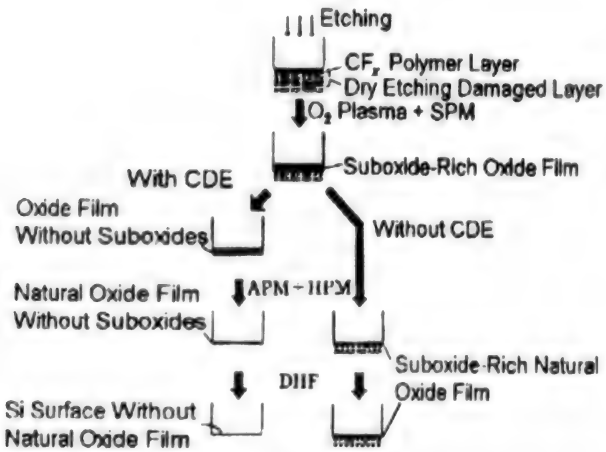


Figure 7. Models of Contact Hole Variation Attributed to Various Processes after Dry Etching

Nuclear Fuel Industry Co. Doubles Uranium Fuel Production Capability for PWR

94FE0513F Tokyo NIKKAN KOGYO SHIMBUN in Japanese 12 Mar 94 p 8

[Text]The Nuclear Fuel Industry Co. (Telephone 03-3433-3111) has doubled the production capability for uranium fuel for the pressurized water reactor (PWR) of the Kumatori Plant. In the process for molding uranium dioxide powder and preparing fuel aggregate, the newly designed line with power conservation and acceleration was enlarged for the uranium pellet production section (preprocessing) such as press and calcination which was just one system before now and operation has begun recently. The annual production capacity at the pellet level was doubled to a maximum of 360 tons (for ten designated PWR). By being made a multiple system, its stable supply function was established, and it was made able to handle future supply and demand expansion as well.

The expansion of the uranium pellet production line of the Nuclear Fuel Industry Co. has come after ten years. It was aligned with the adjoining room (total floor area 1000 m^2) of existing lines with the technology developed by this company and was completed by the end of February. The amount of investment was not made clear. The new line is characterized by the improvement of air-tightness and reliability, the automation of energy conservation, and being made compact with the usage of many robots and an improved walking beam furnace and a soft handling system. An image processing system for automatic external inspection was introduced for testing. Compared to existing lines, the number of operators was reduced by half to five, and pellet production speed was increased 1.6 times to 4 to 4.5 every second.

The Nuclear Fuel Industry Co. receives a supply of uranium dioxide powder of converted concentrated uranium hexafluoride powder, produces pellets mainly for boiling water reactors (BWR) at the Tokai Plant (Tokai-mura, Naka-gun, Ibaraki Prefecture) and for PWR at Kumatori, makes it into the final fuel aggregate, and supplies it to power companies.

Because the number of domestic nuclear plants is at the ceiling and the designated interval also appears to be extending, it is estimated that demand is not presently increasing, but they anticipated trouble and peak time countermeasures in 10 to 20 years and took action for reinforcement.

JAERI Offers Research Cooperation to Tsukuba U. Graduate School

94FE0513D Tokyo NIKKAN KOGYO SHIMBUN in Japanese 9 Mar 94 p 7

[Text]The Japan Atomic Energy Research Institute (JAERI, Director Shosan Shimomura) will perform cooperative research with the Tsukuba University "Cooperative Graduate School". An agreement will be concluded soon. JAERI has the world's highest level of research facilities such as an accelerator, nuclear reactor for research, and fusion facilities indispensable for nuclear power research and the research corps is also substantial. The aim of this research cooperation is to utilize this research basis and foster students.

JAERI has a record of external cooperation such as joint research with 60 universities across the country. Unlike such research cooperation, the form of cooperation with the Cooperative Graduate School is to help the education for the students to become holders of masters and doctoral degrees. It is handled with opening facilities and sending the research corps.

In the plan, atomic particle accelerator physics, energy engineering, nuclear fusion and plasma are the themes of cooperation. Heavy ion nuclear reactions using a tandem accelerator, research of the characteristics of plasma with the application of JT-60 and JFT-2M (High capacity Tokamok development testing equipment), and research of plasma confinement are being performed. Also, there is a plan to perform research of high temperature heat usage systems.

JAERI aims at more open research organizations based on this and intends to realize the same type of research cooperation with the Kyoto Institute of Technology and the Himeji Institute of Technology.

The Cooperative Graduate School of Tsukuba University was established with the objective of utilizing researchers and facilities of national research organizations in Tsukuba Academic New Town and private research organizations in order to foster vital researchers. Cooperation is now called for, with JAERI being a research organization also in Ibaraki Prefecture and finding much merit in lending its power to promote accelerator science and energy research requiring massive equipment.

Editorial: Japan Must Take International Leadership To Alleviate Concerns Over Its Nuclear Intentions

94FE0513E Tokyo NIKKAN KOGYO SHIMBUN in Japanese 9 Mar 94 p 2

[Text] While the U.S.-Japan economic problems are reaching a dangerous state, the fear is rising that Japanese nuclear power policies revolving around the peaceful usage of plutonium will become "embers" of new friction. This is because the distrust of North Korea over nuclear arms has had repercussions in the distrust for Japanese usage of plutonium.

Based on three general principles of denuclearization, Japan's nuclear power policy shows removal to peaceful usage domestically and abroad and promotes the commercialization of nuclear power facilities. This is according to the justifications of safe guarantee of energy and ensuring independence. However, criticism of the United States for Japan's policies from the perspective of nuclear nonproliferation is just becoming stronger. There is also the

viewpoint that if we remain idle, it will develop into external pressure calling for a halt to the construction of the Rokkasho reprocessing plant and prohibition of reclaimed plutonium transport from Europe.

The U.S. harboring feelings of distrust for Japan's denuclearization policy is due to Miyazawa, the prime minister at that time, not supporting the US resolution asking for the indefinite, unconditional extension of the Nuclear Proliferation Treaty (NPT) at the June 1993 summit (G7 summit conference). It is indicated that this is entwined with nuclear distrust of North Korea. Concerning North Korea, the unsettled question of nuclear inspections by the International Atomic Energy Association (IAEA) was mutually agreed upon and was started March 1. The Japanese government also is showing awareness that this only amounts to the first step toward a general resolution.

To the extent that nuclear distrust of North Korea is not completely swept away, the suspicion that "Japan has the power of nuclear deterrence for safe guarantee" raising fear in the countries of the world is not without reason. Moreover, there is a perspective that, with the commercial use of plutonium not paying off economically, advances made regardless of this have the intention of hiding military objectives. Furthermore, with Japan's nuclear armament being discussed abroad, the following are given: the conclusion of the East-West cold war structure, the production of large quantities of surplus plutonium following the dismantling of nuclear weapons, and the alleviation of uranium supply and demand. Additionally, the countries of Europe and America decided to withdraw from the development of fast breeder reactors (FBR) and to convert France's Super Phoenix, which is the first FBR test reactor in the world, to a fast reactor which does not perform breeding for research. It cannot be denied that with such trends of the times, Japan's standpoint of speeding up commercialization of plutonium stands out. Prime Minister Hosokawa showed support of the indefinite extension of NPT directly after inauguration and during the February U.S.-Japan summit as well, gave an address making clear denial of the intention of nuclear armament. Just then, the FBR prototype plant "Monju" built in Tsuruga city, Fukui Prefecture, by the Power Reactor and Nuclear Fuel Development Corporation (PNC) reached the anticipated critical state in April. It is essential that Japan, as the only country bombed with atomic weapons, take global leadership and take the initiative for the transparency of nuclear materials control and nuclear disarmament in order to realize a nuclear-free world.

PNC's Study of Actinide Recycle Finds 5% Mixed Burnup Possible

94FE0513C Tokyo NIHON KEIZAI SHIMBUN in Japanese 28 Feb 94 p 17

[Text]The Power Reactor and Nuclear Fuel Development Corporation (PNC) have gathered the results of a study of actinide recycling with plutonium isolated from nuclear waste for generating power and transuranium of waste matter consumed together in a fast breeder reactor. It is technically possible to mix and consume transuranium up to 5% in core fuel; the consumption by six reactors of transuranium produced with a light water reactor on the same scale is estimated. PNC is accelerating research beginning this summer of the irradiation test which actually used transuranium in the fast breeder reactor "Joyo".

PNC used the prototype reactor "Monju" class fast breeder reactor and made a model of core fuel consisting of 2 tons of plutonium and 7 tons of uranium with 5% added 500 kilos of the three types of transuranium elements of neptunium, americium, and curium. When the percentage added of the transuranium is over 5%, it has a bad influence on core properties such as dropping the melting point of the fuel.

The model can reduce transuranium elements at a yearly average of 40 kilos each. After this nuclear waste is reprocessed and the plutonium for the breeder and the radioactive waste material are removed, and if the reduction of uranium and transuranium is supplemented and fuel is prepared, it can be consumed again under the same conditions.

According to PNC, one light water reactor at the 1 million kilowatt level produces 40 to 50 kilos of transuranium annually on average. Neptunium and americium are both close to 50% and curium is 5% of the transuranium. Of this, while neptunium and americium can be effectively reduced in fast reactors, the weight of the curium oppositely has a threefold increase.

To find the reduction properties of actual transuranium, the irradiation test using imported samples is performed at Joyo. Furthermore, there is a plan to begin trial production of americium system fuel by 1998.

Demonstration Tests on Annihilation of Transuranium with US, France

94FE0513B Tokyo NIKKAN KOGYO SHIMBUN in Japanese 18 Feb 94 p 14

[Text] The Central Research Institute of Electric Power Industry (CRIEPI) will perform verification testing of reduction-electrolytic refining actually using the transuranium for four years starting in 1994 jointly with Rockwell International and Missouri University of the U.S. as the second level of processing technology to separate and annihilate the transuranium from the high level waste fluid produced when reprocessing nuclear waste from light water reactors of nuclear power plants. Also verification testing of the annihilation of transuranium placed in the metal fuel of Phoenix which is the prototype reactor of the fast breeder reactor (FBR) of France is beginning as scheduled for five years from 1994 at the French site in cooperation with the Transuranium Research Institute of the European Union (EU) in Germany.

CRIEPI has begun the development of technology for annihilation with the FBR metal fuel. The objective is to establish radioactive annihilation technology for transuranium elements such as neptunium having a radioactive half-life of over 2 million years.

The dry separation method of CRIEPI consists of a "high temperature cold metal separation process" to perform the conversion (reduction-extraction) of high level waste fluid to oxides and the conversion (chlorination) of oxides to chlorides and the recovery (reduction-extraction) into cadmium of transuranium from within the melted chlorides and refining (electrolytic refining) of the recovered transuranium.

The test facilities in the Komae Research Lab (Komae city, Tokyo) can process imitation waste fluid (nitrate solution) at up to two liters per one day; rare earth elements with similar chemical properties are used instead of transuranium. Data that over 99% of transuranium can be separated and recovered have been attained in the experiments up to now, but since both waste fluids and elements are imitations, it was decided to perform verification tests actually using transuranium in the U.S.

Also, in order to realize annihilation processing by metal fuel FBR and the introduction of transuranium to the FBR fuel cycle, metal fuel with transuranium mixed in a three element alloy of uranium + plutonium + zirconium was prepared in cooperation with the Transuranium Research Institute. For investigating whether transuranium is mixed with the other three elements and whether it has the properties to serve as the nuclear fuel, nine rods of metal fuel mixed with transuranium will be actually placed and consumed in Phoenix reactor and the verification testing of transuranium annihilation will be performed.

JAERI Develops Device To Cut Up Used Reactor Components for Disposal

94FE0513A Tokyo NIKKEI SANGYO SHIMBUN in Japanese 26 Jan 94 p 5

[Text] The Japan Atomic Energy Research Institute (JAERI) developed equipment for cutting used instruments having strong radioactivity from nuclear reactors into small parts under water. It employs the method for cutting while melting with electric discharge and while it is such that almost no small scraps are ejected, it combines three types of water purification systems so the spread of radioactivity is suppressed. Before now, there was no such equipment and long pipes having strong radioactivity were sunk in that condition under water and preserved; they were unwieldy and became an obstruction to experiments.

The new equipment was developed for the Materials Testing reactor JMTR (thermal output 50,000 kilowatts) in the JAERI Oarai Research Lab. In JMTR, the space of a laboratory to examine nuclear reactors and irradiated materials connected to a 6.5 meter deep, 3 meter wide waterway and the new device is installed in this waterway.

With the base in the form of a two meter rectangular parallelpiped, the device itself intercepts the space between it and the waterway when it receives the pipe to be cut so that the water way is not contaminated with the cutting operation. Cutting is performed while an arc discharge is generated with a disk shaped blade with thickness 1.6 mm and diameter 15 cm rotated 800 times each minute as voltage is applied in the space between the knife and the object to be cut.

With this system, very few scraps and gas are emitted, but the tiny scraps which are emitted are recovered by means of a filter and ion exchange resin. It is unique in that a filter employing magnetic force is used. Usually stainless steel which is not magnetized is used for instruments from nuclear reactors, but the scraps can be gathered with magnetic power since, after they are heated to high temperatures, they are rapidly cooled and magnetized.

At JAERI, the new device was used to cut three multiplex pipes having diameter 15 cm, length 5 meters, and strong radioactivity reaching a maximum 4000 curies many times; its utility was verified.

Furukawa Co., Ltd. Develops New Carbon Dioxide Laser for Dentistry

94FE0674B Tokyo KAGAKU KOGYO NIPPO in Japanese 26 Apr 94 p 5

High-efficiency optical fiber for use as a CO2 laser scalpel

Safe for the body with high workability

Medical/Biological/Food

Commercialization of Furukawa equipment (Initially for dental applications)

Furukawa Co, Ltd. will commercialize optical transmission fibers for laser scalpels using CO2. Silver halide crystals, which are used as the core material, have no adverse effect on the body. They are made into 3 meter-long practical transmission lines. Such lines have transmission efficiency exceeding 80%, and are capable of optical transmission of 20 watts of power. They present the prospect of use in the arm of laser scalpels which are used in dental treatment. Recently, a mass-production system which can handle one thousand meters per month was set up at the Iwaki Factory (Fukushima-ken). The operational properties when applied to invasive surgery are far superior to the present product, which uses reflecting mirrors. The company will cooperate closely with manufacturers of medical equipment to develop new applications.

Material... Silver halide

Furukawa Co, Ltd. is going to set about producing optical fibers for medical use. The fibers are collected into a 0.5 mm bunch of fibers of silver halide crystals covered with a shield cover. A uniform 0.1 mm space is maintained between the fibers and shield cover through a special technique. This is devised so that infrared light such as CO2 lasers will pass through the space. This product has a practical length of 3 meters and can hold down the transmission loss to under 20%. It is also capable of 20 watts of power/optical transmission.

The unease concerning adverse effects on the body of thallium-based optical fibers, which are presently used occasionally in laser-scalpel applications, is eliminated. The workability is far superior in comparison to that of current products in which small reflecting mirrors are connected using tubes, and this equipment can also be easily applied to such treatment as cancer excision.

Furukawa Co, Ltd. is planning commercial production in the near future of an arm for the scalpel used in dental treatment. Production facilities have been transferred from the Hino Research Center (Tokyo), where work had been carried out until last year, to the Iwaki plant, and a mass-production system with a monthly capacity of 1,000 meters has been completed.

From now on, this company plans to actively promote new applications for this equipment while cooperating closely with manufacturers of medical equipment.

Japan's Participation in International Group's Discovery of Top Quark

94FE0673B Tokyo NIKKEI SANGYO SHIMBUN in Japanese 24 Apr 94 p 3

[Text] Nuclear fusion experimental reactor

Four-polar joint project of Japan, America, Europe and Russia

Engineering design activity (EDA) to construct the "International thermal-fusion experimental reactor (ITER)," an international joint project promoted by the four entities of Japan, the United States, EU and Russia, was formally set in motion this year. The purpose is to verify the technical possibility of nuclear fusion energy. A joint central team working on EDA will start a detailed plan of ITER. As it progresses in determination of the dimensions of the main structure of ITER, it is going to complete a design aiming at low cost of construction and a compact system. According to the Science and Technology Agency, it is scheduled to submit an interim design plan that is more detailed than the ITER outline to the Technology Inquiry Committee, which is directly connected with the ITER board of directors, in the spring of next year.

The nuclear fusion reaction utilizes massive amounts of energy that is generated when the nuclei of tritium and heavy hydrogen, an intermediary (isotope) of hydrogen, fuse. To generate this nuclear fusion energy, the fuel temperature must exceed 100 million degrees centigrade and the fuel inside the container must be held at high density for a prolonged period to continue the nuclear fusion reaction. The tokamak system is an effective method of confining high-temperature fuel called plasma so as not to touch container walls. Japan, America, Europe and Russia possess nuclear fusion experimental devices that adopt this method. The aim of the ITER project is to achieve the production of energy by nuclear fusion [self-ignition conditions] (the condition in which a nuclear fusion reaction continues without outside input.), and to then proceed to develop an experimental reactor.

EDA started the 6-year project in July 1992 after obtaining good results in the first-step conceptual design activity. They firmed up an outline of the ITER system, materials and accessory equipment in the first 20 months of EDA, submitted a design draft which presented that in diagrammatic form to the board of directors, and received authorization from the board of directors in January of this year. Subsequently, details will be decided in the second-stage detailed-design activity, including dimensions of the blanket (section surrounding the reactor core plasma), which had not been determined in the preliminary design. The last draft of the design is to be settled by approximately 1998.

The EDA joint central team is established in San Diego in the United States, in Galhink [phonetic transliteration] in Germany and Naha, Ibaragi-ken, Japan. Each local group cooperates with teams in their own country

and proceeds with design work. Japan is responsible for the design of the superconducting coil outside of the vacuum container and for the heating equipment.

NEC Develops New Semiconductor Laser

94FE0545C Tokyo NIKKAN KOGYO SHIMBUN in Japanese 23 Mar 94 p 7

[Text] NEC (Mr. Tadahiro Sekimoto, President) has for the first time developed a gallium arsenide 0.98 microns high precision semiconductor laser into an erbium doped fiber (EDFA) excitation light source to be used in a 1.5 microns linewidth optical communications system. For the sake of reliability, indium phosphorous type 1.48 microns semiconductor lasers have been used in the excitation light sources developed up to this point. This time, NEC strove to control faults and improve reliability by providing the 0.98 microns laser with a unique structure which is superior in low noise amplification and low power consumption. The device obtained was tested in reliability experiments which assumed that a lifespan of 100,000 hours was necessary for communications. NEC was able to create a high performance optical receiver that is several times faster, but able to keep power consumption to one half that of conventional devices.

The excitation light source NEC developed is a 0.98 microns linewidth laser that uses a gallium arsenide substrate. Conventional lasers made from this same material easily generate inversion faults, causing performance to suddenly deteriorate during use. Because of this, highly reliable indium phosphorus type 1.48 microns linewidth lasers are used for excitation light sources.

However, the gallium arsenide type has a shorter wavelength, and as the excitation energy becomes higher, it can lower the noise component included in the signal light, and it can improve the reception sensitivity two fold. Also, because it has a high electro-optical output conversion efficiency, the energy consumption can be reduced by one half.

Thus, in order to suppress the inversion faults in the 0.98 microns lasers, NEC provided distortion barrier layers on both sides of the distortion quantum wells such that the lattice constants of both sites change gradually for the purpose of softening the difference in lattice constants between the indium gallium arsenide distortion quantum wells of the activated layer and the crystals of the gallium arsenide optical guide layer. In addition, there are two layers of distortion quantum wells, and by making a surface type ridge embedded structure, the device can be made capable of stable action even under high temperature and high output.

Oscillating from 18 milliamps, the prototype laser obtained optical output characteristics of 300 milliwatts or more. When connected to fibers, it was highly efficient at 51%, and realized an EDFA optical output of 100 milliwatts. In reliability tests, 100 milliwatt optical output tests at 50° C and 70° C were conducted and in both cases, it was confirmed that there was no sudden deterioration of characteristics over a period of 3,000 hours or more.

AIST Develops Ultra-Precision Nano-Scale Manipulator

94FE0545B Tokyo NIHON KOGYO SHIMBUN in Japanese 8 Mar 94 p 7

[Text] The National Research Institute of Metrology, AIST (Mr. Yoshiharu Kurita, Director) and Kanetek (Mr. Takahito Nakashima, President, Ueda City, Nagano Prefecture, Tel 0268-24-1111) have jointly developed a new type of manipulator that can move objects with high precision on the nanometer scale.

This device has strong drive force and retention power, and uses a stage to move an object of up to approximately 15 kg in a horizontal direction. It also involves the technique of mounting a laser interferometer [on the object] to detect the gradient and twist during movement, and to determine the position with high precision. The manipulator best manifests its power in the precision positioning of objects that humans cannot access.

The manipulator that has been developed is called the "nano-worm" and it alternately moves the front and back feet in fine steps like an inchworm. There are four piezo electric elements connected between the front and back feet, and these are the drive source.

The size of the front and back feet are 3^2 cm, and they incorporate neodymium type permanent magnetic blocks which have built-in coils. When moving, the legs on one side are adsorbed to the floor surface by the permanent magnetic force, and the legs of the other side float up from the floor surface because the magnetic force is canceled by running electric current. The technique is based on allowing movement by alternately repeating this action. The elements move 10 microns in one expansion and contraction, and when causing movement on the nanometer level, they are controlled by voltage.

Past manipulators that used piezo electric elements as the drive source employed electromagnetics in the feet material, and therefore heat was generated when running the electricity, and at times the expanding and contracting movement of the piezo electric elements became skewed.

The new manipulator overcomes such problems by using permanent magnets in which heat generation does not occur, and by mounting the laser interferometer for displacement detection that plays the role of the "eyes" on the back of the object.

AIST Develops New Technology for Measuring Atoms in Ultra Vacuum

94FE0545A Tokyo NIHON KOGYO SHIMBUN in Japanese 3 Mar 94 p 6

[Text] The Electrotechnical Lab, AIST (Mr. Kitaro Toyama, Director) has become the first in the world to develop technology that can visualize atoms and molecules in a vacuum.

They were successful in ionizing the few atoms and molecules remaining in a vacuum, and detecting their vacuum distribution by an image. If this is combined with the "atom counting method", which has already been developed by the Electrotechnical Lab to count atoms and molecules, it will be possible to measure the density of gaseous atoms in an ultra high vacuum region.

To induce this ionization, a method called 'non-resonant multiphoton ionization' is used in which the electrons within atoms are ionized by absorbing numerous photons at one time. The laser used is a YAG (yttrium, aluminum, garnet) laser, and it irradiates a second harmonic with a wavelength of 532 nm.

Specifically, the laser light is irradiated on one point which is made the optical focal point by an optical lens, and the atoms and molecules near the focal point are ionized. The method involves counting the number of ionized atoms and molecules by passing them through a static electric lens made of two electrodes and capturing them by a microchannel plate (MCP) detector. The MCP detector is a device which brings together several million honeycomb shaped electron multiplication tubes each of which have a diameter of about 10 microns, and the distribution of atoms and molecules are displayed by the ions which have entered the tubes reaching the coalescence point and casting a shadow on a phosphor screen.

By combining use of this atom counting technology with the direct observation of ion production regions, it becomes possible to measure molecular density in ultra vacuum areas. Thus, there are plans at the Electrotechnical Lab to conduct research that aims to create and measure ultra vacuum regions of $1x10^{-11}$ pascal by attaching this newly developed ion detection system to an ultra high vacuum device.

JAERI Develops New Synchrotron for Use in ITER Project

94FE00674A Tokyo NIKKAN KOGYO SHIMBUN in Japanese 25 Feb 94 p7

[Text] Completion of gyrotron that collects energy

Scientific technology

Accelerate the development of nuclear fusion reactor

Possibility of high efficiency and miniaturization

The Japan Atomic Energy Research Institute (Director Mr. Shozo Shimomura) has succeeded for the first time in developing an energy-collecting type of gyrotron. The objective of this gyrotron is to serve as an energy source for an international thermal-fusion experimental reactor (ITER) and nuclear fusion power reactor. That would permit efficiency to be raised while reducing the size. This research center will strive for practical application while continuing theoretical verification testing of performance and energy collection of this gyrotron. Plasma which has high temperature, high density plasma and a long duration of residence in a reactor is required for the development of nuclear fusion reactors. A gyrotron is responsible for providing energy to the plasma which induces nuclear fusion and for stabilization of the plasma which is then generated. If practical experiments succeed, the development of nuclear fusion reactors would progress considerably.

In cooperation with Toshiba, this research center has succeeded in the development of the world's most advanced gyrotron which is capable of 110 gigahertz and 410 kilowatts output with high-frequency oscillation of 1.3 second pulse amplitude. These results represent the fruition of this research and will constitute the basis for the development of gyrotrons capable of continuous operation at high output of one megawatt, which is required of an international thermal-fusion experimental reactor or of a nuclear fusion power reactor (commercial reactor).

A gyrotron captures high frequency by generating electron beams via an electronic gun and then converting the electronic beam energy into high frequency. The research group at this research center has achieved results which are neck-and-neck with the highest in the world by the method of completely separating high frequency output from electronic beams when creating high frequency output from electronic beams.

Major elevation of the acceleration voltage of the electronic gun is necessary in order to elevate high-frequency output. However, problems arise which include elevation of the power source to raise the voltage, and that leads to deterioration of gyrotron efficiency.

The gyrotron which was developed here solved this problem in one stroke by applying reverse voltage between the connector and the body of the gyrotron, thereby collecting electronic energy which has completed high-frequency conversion. Specifically, the acceleration voltage (voltage between the cathode and body) is set to 80 kilovolts and the main power source voltage (voltage between cathode and collector) is set between 50 and 80 kilovolts. By insulating the collector from the electronic accelerator and applying a reverse field, energy is collected in the form of electronic beams which fly into the collector.

This research center will continue experiments until April or so to confirm its capabilities of 1.5-fold rise in efficiency, one-half reduction in power capacity and decrease in cooling system to ⅓ that of a conventional unit. Using the results of this experiment as the bases, the Japan Atomic Energy Research Institute will proceed step-by-step with the development of an ITER 170 gigahertz gyrotron of the 1 megawatt class with long pulse and the capability of continuous operation.

MITI To Hold Regular Meetings with Indonesia, Malaysia, Thailand for Industrial Technologies

94FE0649A Tokyo NIHON KOGYO SHIMBUN in Japanese 8 Apr 94 p 1

[Text] MITI agreed to hold periodic bilateral policy discussions concerning industrial technology with Indonesia, Malaysia, and Thailand. Persons at the rank of bureau chief and responsible for industrial technology will exchange opinions at a rate of one or two times annually; along with providing policy methods and know-how for the fostering of industrial technology accumulated by Japan, they will connect matters of concrete technical cooperation such as joint research by national research organizations. The ASEAN countries are dealing with the establishment of their own technology as a condition indispensable for industrial development, but the areas of interest differ greatly from country to country. By advancing the bilateral policy discussions, a cooperative relationship confirming their respective needs is constructed.

The plan is to establish occasions for policy discussion with both Singapore and the Philippines successively.

With the opportunity of Minister Habibi of Technical Research making a visit to Japan in June, MITI Minister Kumagaya will hold the initial industrial technology policy discussion with Indonesia. Beginning with the technical advance of industries with high employment absorption and industries using natural resources, this will aim also at research cooperation in advanced fields such as aircraft and new materials.

With October as the target for holding the bureau chief meeting with Malaysia, the Japanese side will propose concrete cooperative measures. This country aims to strengthen the technical basis for local industry and is trying to decide the fields on which to focus government tools such as the tax system and financing. Therefore, there is much interest in the government policy know-how of Japan such as the method of organizing private businesses and policies to foster small and medium enterprises.

Meanwhile, Thailand decided to establish an organization to examine policy discussions through the Science, Technology and Environment Ministry. Policies to support R&D by businesses, environmental technology, and new materials development are being examined as areas of cooperation. Cooperation towards effective utilization of tapioca (starch made from potatoes) is also performed.

MITI, MOT To Accelerate Popularization of Natural Gas Vehicle

94FE0649B Tokyo NIKKAN KOGYO SHIMBUN in Japanese 18 Apr 94 p 21

[Text]The government will accelerate the popularization of natural gas vehicles (NGV) from this year. The officials of MITI and MOT with the Environment Agency established a subsidy system for preparing gas filling stations and the vehicle leasing business in the 1994 budget proposal and included a subsidy totalling ¥1.91 billion, 3.5 times that of the previous year.

The Japan Gas Association (Chairman Hiroshi Watamade) supports the plan to newly introduce 367 NGV this year and raise the number in use by 2.6 times the current number. With the opportunity of the preparation of a natural gas supply system in the three regions of Kansai, Chubu, and Kanto, designated as special regulation zones by the Automobile Nitrogen Oxide (NOx) Act, NGV which have high efficacy for NOx reduction will undergo major acceleration for marketing.

The established "natural gas vehicle popularization acceleration policy subsidy" is a total of ¥830 million including the tertiary revised budget increase in 1993. The main issues are a 50% subsidy of automobile conversion costs for leasing enterprises and a subsidy of the construction costs of filling stations to supply natural gas; both will serve to develop a basis for filling stations and the reduction of vehicle costs which are the problems of popularization.

The lease subsidy is through the gas association and this year the amount for 70 vehicles (¥200 million) was appropriated. The plan is to construct seven filling stations (¥620 million) were scheduled with the subsidy for new construction and 14 stations with the allotment for the "Ecostation 2000 Plan" for stations with other fuels such as gasoline (¥740 million).

With this, this association plans to introduce a total of 367 vehicles such as 72 of the Mazda 2-ton trucks called "Titan." Besides gas enterprises leasing them for business use, regional municipalities will lease them for garbage collection and buses.

While the NOx in the exhaust gas of NGV is low at one-third that of diesel vehicles, the operating distance per one fill-up is short, 200 kilometers with light cargo, and the vehicle price is three times that of gasoline vehicles. Furthermore, because of the delay in preparing a fuel supply network, the number of vehicles in use is currently only 243.

However, the municipal gas system for natural gas was completed by Tokyo Gas in 1988, Osaka Gas in 1990, and Toho Gas in 1993. Furthermore, because all three regions became special zones for vehicle type regulation by the Automobile NOx Act, NGV are suddenly noteworthy as alternative fuel vehicles and are expected to gain momentum in popularization with this government support.

MITI To Begin "WE-NET" R&D

94FE0649C Tokyo NIKKAN KOGYO SHIMBUN in Japanese 21 Mar 94 p 1

[Text]In 1994, MITI Agency of Industrial Science and Technology (AIST) will start R&D for the "Hydrogen Utilization International Clean Energy System Technology" (WE-NET), an energy-environment technology

development project. With the formal decision to participate in Canada's Canada Hydrogen Industrial Association, which has global results in hydrogen research, the cost of renewable energy such as water power and wind power and effects on global environmental protection will be investigated. At the same time, the development of technologies for production, transport and storage, and utilization will be started. Also, about 20 research groups from the United States, England, Germany, and Italy have expressed intentions to cooperate and the project will be advanced for the resolution of global scale environmental and energy problems.

WE-NET is aimed at the construction of a network for the transport, storage, and utilization in the world's consuming regions and the conversion to a transportable form such as hydrogen of clean renewable energy such as sunlight and water power which are abundant and unused in the developing countries. This is a long term project with the target year 2020 and if realized, the imbalance of energy supply and demand on a global scale will be resolved. Also, the use of clean hydrogen is noteworthy with the tentative calculation that the amount of carbon dioxide (CO2) exhausted in the world can be reduced 10 to 20% in the first half of the 21st century.

However, besides renewable energy being ubiquitous in each region of the world, transfer being necessary makes international cooperation indispensable.

The Canada Hydrogen Industrial Association, participation in which has been decided, was founded in 1982; power and gas companies and universities are members, along with the Canadian federal government and six state governments. With international cooperation, basic research in the four areas of production technology, transport and storage technology, and utilization technology will conclude in 1996 and the design, construction, and operation of small scale plants will begin in 1997. In 2020, the intention is to establish pilot systems on a global scale.

MITI To Reinforce "Green Aid Plan"

94FE0649D Tokyo NIKKAN KOGYO SHIMBUN in Japanese 21 Apr 94 p 2

[Text] MITI is expanding the scale of operations in 1994 to add Malaysia and the Philippines to the target countries of the "Green Aid Plan" to support energy conservation measures and environmental improvement in developing nations. Beginning with the new establishment of Energy and Environmental Technology Centers, liaison and coordinating organizations, in the three countries of China, Malaysia, and the Philippines, MITI set the budget at ¥14 billion, a 17% increase in total compared to the previous year, to redouble the funding of countermeasures for Chinese ironworks compared to 1993, for example. Developing countries have intensifying environmental problems due to precipitous economic growth and MITI would like to add the Japanese pollution countermeasure technology and know-how, which is at the highest level in the world, and link it to the environmental improvement of developing countries.

Already MITI is promoting policy dialogue at the business level with both Malaysia and the Philippines; a pilot plant for solar generated power in Malaysia and the construction of low cost desulfurization equipment in the Philippines were decided upon. Also, in addition to dispatching five to ten specialists to each of both countries, it was decided to receive about twenty research students.

Meanwhile, in the activities to support environmental improvement for the Chinese ironworks started in 1992, three locations will be added in addition to the two current locations of Chungching and Paotou, the ironworks which became the subject, and for the budget as well, the ¥900 million of 1993 will be increased to ¥1.8 billion. Furthermore, continuing with Thailand and Indonesia, there is a plan for the new construction of Energy and Environmental Technology Centers in China, Malaysia, and the Philippines during 1994 and to station full service personnel permanently in each country.

The Green Aid Plan has the objective of supporting the self-reliant efforts of developing countries concerning environmental improvement and was advocated by MITI in August 1991. It was started in 1992 beginning in China and Thailand; Indonesia was added to the target countries in 1993. Japan and the target countries had policy dialogue concerning the elimination of problems in the subject areas of preventing water and air pollution, waste product processing, recycling, energy conservation, and alternative energy. As the second stage, it was decided to perform joint research and verification testing of environmental technology, investigation concerning environmental policies, and the dispatching of specialists.

MITI Announces New Industrial Policy

94FE0649E Tokyo NIKKAN KOGYO SHIMBUN in Japanese 21 Feb 94 p 1

[Text]The outline of the energy field was made clear in the new industrial policy "New Industry Establishment Program" in which MITI promotes policies. Aiming for the full-scale introduction of new energy systems in the year 2000, it incorporates as the easement of regulation the movement to a formal recognition system from the individual recognition of the setting of Japanese Industrial Standards (JIS) for residential solar power systems and of the Highway Transportation Vehicle Act for clean energy automobiles. Also, the target of introduction of solar power generation in the year 2000 is on the scale of 80,000 residences with 250,000 kilowatts. New energy is important in order to make the energy supply system flexible because it becomes the linchpin of future energy policies for the expansion of choices for consumers and with environmental problems.

New energy policies consist of "Future subjects of new industrial areas" and "Policy issues." New industries

shows the targets of introduction in the year 2000. Solar power generation at 250,000 kilowatts puts the power generation costs of a usual household on a level close to a current power bill (less than ¥ 30 per one kilowatt hour).

For clean energy vehicles, the targets are to contrive cost reductions such as increasing the running capacity with electric vehicles and beefing up recharging stands and an annual production of 100,000 vehicles which run at a speed per hour of 40 kilometers for 250 kilometers on one charge.

Trash exhaust heat from sanitation plants and temperature difference energy such as sewer systems and seawater in the vicinity of cities introduces 3 million kilowatts with crude oil conversion. Snowmelt systems making compound application of solar heat and soil heat will make a ¥ 200 billion market in the year 2005. Waste matter power generation aims to expand the current 360,000 kilowatts (120 plants) to 2 million kilowatts and 400 plants by the year 2000.

The easement of regulation, which is the major policy issue, is examining the promotion of electricity sales to power companies, the preparation of systems to accelerate participation in new enterprises, and the easement of the preservation system for the popularization of distributed power sources. Also, the easement of regulations of clean energy vehicles, unused energy, and gas enterprises is promoted. Gas enterprises already have decided upon liberalization. Therefore, there are also policies to ease legal regulations related to other ministries and agencies.

MITI To Start Water Treatment R&D for Oil-Contaminated Sea Water

94FE0649F Tokyo KAGAKU KOGYO NIPPO in Japanese 15 Apr 94 p 1

[Text] Next year, MITI will start developing purification technology for oil-contaminated sea water. In the Persian Gulf, water is attained by desalinating sea water, but the crude oil spills in the Persian Gulf War produced the problems of the destruction of the membranes in sea water desalination equipment and the mixing of oil in the desalinated water. Therefore, as part of the policy to support the preparation of an industrial base in the oil-producing countries, it was decided to develop purification technology combined with crude oil decomposition utilizing microorganisms, as well as developing new functional membranes. The investment of ¥ 100 million to ¥ 150 million over four years is planned.

A budget for this year of ¥ 11 million as a 100% subsidy of petroleum special accounts was appropriated for the development of purification technology for oil-contaminated sea water. The Petroleum Energy Center (PEC) commissioned the Water Production Promotion Center. Studies are being collected by the research society in the Water Production Promotion Center and it is estimated that as early as next month the committee in which businesses participate will formally start and begin technical development.

Hydrophilic membranes to which oil adheres with difficulty and oil decomposition methods using microorganisms are being developed. Ceramic system inorganic membranes and organic membranes of polyvinyl alcohol and polyolefine systems are the subject of study for hydrophilic membranes. Also, methods are considered in which there are (1) infiltration with hydrophilic agents, (2) transplantation of hydrophilic groups, (3) coating with hydrophilic materials in the membrane holes.

For petroleum decomposition due to microorganisms, the method in which the microorganisms are confined in a gel material and suspended inside a tank is advancing at the laboratory level, but this has the disadvantage that the gel becomes worn and research for the adhesion of the microorganisms to the membrane is continuing.

Additionally, the optimization of the modular form and the configuration and the development of membrane washing equipment are being performed; finally, the plan is construction as a system. This year, the essential technology such as the pressing of the membrane material and the general design of the system will be made.

This technical development is one part of the policy to support the preparation of an industrial base for oil-producing countries. It also has the added significance of the development of sea water desalinization technology promoted by MITI. There is oil pollution and contamination by heavy metals of the sea water on the coast of Japan and this could also be of use in these respects. MITI also determined that the range of application is wide, not only for sea water purification, but also for the extraction of useful materials.

MHW To Re-examine 5-Year Health & Welfare Research Plan

94FE0649G Tokyo KAGAKU KOGYO NIPPO in Japanese 13 Apr 94 p 5

[Text] Next month, the Ministry of Health and Welfare (MHW) will reexamine the 5-Year Health & Welfare Research Plan at the Health & Welfare Science Conference (Chairman Takashi Sugimura). The current 5-Year Plan was established in September 1988; it determined the establishment of the basis of health and welfare research and the research fields to emphasize in order for breakthroughs and advocated the performance of research according to the project system. However, following that were major changes such as the ambitious 10 year strategy entering the second phase and genetic treatments entering the era of clinical applications from basic research. Also, since it was decided to review this plan in about five years, it has been decided to make a new plan.

In order to deal with social economics and health science development, the Health & Welfare Research Plan clearly states the emphasized research areas with the research system, research financing, and support system.

Other ministries and agencies such as the Industrial Technology Commission of MITI and the Science Council of the Ministry of Education established councils for science and technology policy and determined policies. MHW's use of the Health & Welfare Science Conference as a place to examine such research strategy was connected to the preparation of the 5-Year Plan.

The results of research in medical treatment, welfare, and life sanitation can be enjoyed by the whole world. The Japanese health and welfare research costs may be said to be appropriately increased and are on the scale of ¥70 billion annually. The scientific research costs of the Ministry of Education related to medical treatment are only on the scale of ¥30 to ¥40 billion. The US National Institutes of Health have an annual budget of ¥1 trillion (¥300 billion if personnel costs are excluded) and there is still a big difference. Also, Japan lags behind the United States in advanced medical research such as genetic treatment and is still minor in terms of global contributions.

The areas emphasized in the current 5-Year plan are cancer, geriatric and adult diseases, mental and neurological patients, infectious diseases, organ technology, genetic treatment, drug development technology, safety evaluation science, life support technology, and medical treatment technology evaluation methods.

During this time, the second phase of the ten year strategy for cancer was started; for geriatrics, the long life science research center began operations; and for organ transplants, the conclusion of clinical brain death examination was made. Also, the changes from the times when the plan was established such as the change of disease structure and the progress of genetic treatment to the level of clinical applications are major.

MHW considered the progress of science and technology in all such health sciences and changes in environmental conditions and decided to promote the review of the 5-Year Plan.

EA Establishes 5-Year Plan to Evaluate Environmental Technologies

94FE0649H Tokyo KAGAKU KOGYO NIPPO in Japanese 6 Apr 94 p 7

[Text] In order to respond to apprehensions such as whether the control of final processing plants for waste connected also to serious groundwater contamination is all right, the Environment Agency (EA) has decided to set about the evaluation of waste disposal technology. It also decided to investigate current recycling technology because of recycled harmful material which is not appropriately treated.

A particular problem at final waste disposal sites (landfills) is the contaminated water from harmful materials which were thrown out mixing into the groundwater. The contaminated water must be isolated in order to protect municipal water sources, and a large number of manufacturers are merchandizing equipment which can instantly measure that in the case of emergency leakage of contaminated water. Thus the EA decided to start evaluating the capacity of such equipment. Furthermore, it is also promoting research of technology for restoring contaminated water, the source of which is final disposal sites.

It was decided to research and evaluate appropriate recycling technology for waste materials as well. Recycling is outside the control of waste material processing methods; the standards of recycling in consideration of environmental protection were not established in particular. Therefore, contamination of the environment due to inappropriate recycling of harmful materials is also considered. Because of such things, the EA will examine appropriate recycling methods at the time of final disposal along with evaluating various types of recycling technologies.

Over the next five years, the evaluation of the following will be performed: technology to reduce solubility of harmful materials, technology to decompose harmful materials, technology to detect leaks of contaminated water at final disposal sites, recycling technology, and technology to restore environmental contamination of final disposal sites, necessary when making appropriate final disposal of waste materials.

AIST To Develop Self-Generation Type EV Using Fuel Cell

94FE0649I Tokyo NIHON KEIZAI SHIMBUN in Japanese 21 Apr 94 p 1

[Text] MITI Agency of Industrial Science and Technology (AIST) will begin the development of a new electric vehicle including a small fuel cell to convert the energy of chemical reactions as is into electricity. This is a so-called "self-generation electric vehicle" which runs while it generates electricity itself with methanol which is a type of alcohol as the fuel. Besides not having the difficult charging operation which is a barrier to the popularization of electric vehicles, the exhaust of atmospheric contaminants such as black smoke and nitrogen oxides (NOx) is suppressed to zero. Over the next four years, it will work on the improvement of fuel cells and aim at the application in large vehicles such as trucks and buses.

Basic research was entrusted to fuel cell manufacturers such as the Mitsubishi Electric Corporation and they dealt with the development of miniaturization of phosphoric acid fuel cells and technology for efficiently drawing energy from methanol. The policy is for starting to work with automobile manufacturers after 1998 and promoting full-scale application research.

In the development plan, phosphoric acid fuel cells to be utilized in power generation facilities for industry will be miniaturized to 40 to 50 centimeters square, combined with batteries and electric motors, and form driving systems. While the motor is run with the electricity generated by the fuel cell and the wheels are driven, the extra electricity is stored in the battery and is used during startup and acceleration.

Since fuel cells included in new vehicles use a chemical reaction and take electricity directly from the fuel, the power generation efficiency is high at 40 to 60% and the generation of atmospheric contaminants such as NOx is suppressed almost to zero. The generation of carbon dioxide which is a cause of global warming is also low.

Electric vehicles are expected to be low pollution vehicles having little environmental impact, but the distance which they can run on one charge is only about 100 kilometers and the preparation of a large number of "charging stations" is necessary for popularization. The charging operation usually takes about one hour, but the new vehicles are finished with just a supply of methanol and can solve that problem.

MITI To Build Test Plant for Recycling Waste Plastic

94FE0649J Tokyo NIHON KOGYO SHIMBUN in Japanese 24 Mar 94 p 2

[Text]MITI decided to build a test plant for thermal recycling effectively utilizing industrial waste plastic as the energy source at the Ube Plant (Yamaguchi Prefecture) of Ube Industries, Ltd. The Clean Japan Center (President Akira Mitsuki) commissioned by the New Energy Development Organization (NEDO) will conclude a joint research agreement with the group of three companies of Ube Industries, Ube Ammonia Industries, and Ube Cycon within the month. The plant will be completed by December and verification testing will begin in 1995. The processing capacity is undecided, but is estimated to be on a scale of several ten thousand tons annually.

With verification testing, the aim is for application technology in order for effective utilization as an energy source of waste plastics which are difficult to cope with because of the damage to the furnace in existing incineration facilities due to high calories. It will be operated as the plan for the four years from 1993 until 1996 and total financing is planned to be ¥370 million.

The system consists of the collection division and the solid fuel division. In this, the collection system pulverizes, separates, and collects from the discharge source according to the type of industrial waste materials; each industrial waste material is stored in containers and controlled with a magnetic ID card. Also, the solid fuel system blends many types of industrial waste as fuel based on the information in the magnetic ID card in a state with little variation in quality and makes it solid fuel through the energy conservation process.

This can mix high energy waste plastics and lower energy paper and mud in optimum percentages and can produce solid fuel with little pollution value such as atmospheric contamination and which does not damage the furnace.

Currently, 6.2 million tons of waste plastics are discharged annually; over 70% of this undergoes reclamation processing and simple incineration and effective utilization has become an issue from the perspective of environmental policy.

Japan-U.S. Military Technology Cooperation

946C3812A Tokyo JAPAN-U.S. MILITARY TECHNOLOGY COOPERATION in Japanese 10 Mar 94 pp 1-8

[Article by Aihiko Ueda, Defense Research Center]

[Text]

1. Introduction

Interchange between Japan and the United States began in 1853, about one and one-half centuries ago, when the four warships and trade ships led by Admiral Perry appeared off the coast of Uraga. It is extremely important to start discussion on the security of Japan over a broad range, based on the current relationship between Japan and the United States and reflecting upon the Pacific War a half century ago.

Even with the termination of the cold war, issues concerning security cannot be neglected if any nation is to maintain its basic existence. New frameworks and consideration for security have been discussed in broader perspectives by Asian and Pacific nations, where there are new unstable factors, as well as by European nations, centered around NATO. This indicates that, instead of limiting defense capabilities to military force in the narrow sense, such as fighting power, equipment, number of men, etc., more effective defense policies, including invisible defense awareness among the people as a whole, defense technology and organizations sufficient in quality and quantity, have been introduced as part of the worldwide trend to reduce military spending. When such an idea is viewed from a wider perspective, the security of a nation is related more or less to all the functions of that nation. In particular, although it is natural for economic issues to have a fundamentally close relationship with national security, there are some natural limitations in that Japan which tends to think of the two separately.

It is not useless to describe ideal images of the United Nations and one of its organizations, the Security Council. However, if discussion remains idealistic, lacking military perspectives, and Japan is unable to make international contributions as an ordinary nation in the sphere of real-life activities, it will be impossible to gain reliability on the international level. The Japanese will then be regarded with contempt as "economic animals" who are interested only in money.

Upon considering Japan's security from an international standpoint, adherence to the Japan-U.S. security system becomes increasingly important, and more active responses from Japan are expected from now on. This paper will discuss the central role of technological cooperation between Japan and the United States in such a context and to consider concrete actions to be taken in the future.

2. Japan-U.S. Relationship

The relationship between Japan and the United States deepened after the Pacific War was terminated. During

the Meiji Era, the army and navy had been modeled after those of France, Germany and Britain. The main part of the diplomatic mission was located in Europe at that time as well.

After World War II, due to the increasing importance of the United States with respect to military, economic and technological power, its international role produced substantial results as a result of extreme efforts and burdens in such areas as voluntary activities as policemen of the world, the intensified East-West conflict represented primarily by the Soviet Union and the United States, and wars and struggles related to religions and oil. Under the protection of powerful America, Japan took advantage of the nuclear umbrella, receiving military and other vital information from the United States from a strategic standpoint and using the opportunity to train a number of cadre of the Ground, Maritime and Air Self Defense Forces at military schools and military units in the United States each year. Moreover, as for defense-related equipment, Japan received various arms, warships, and aircraft at no cost, even though such equipment was not at the top level at that time. After Japan became independent, the United States contributed directly to Japan's defense by providing onerous equipment and licensed production, as well as through the improvement of defense technology. The technological standards for the research and development of equipment in Japan were also enhanced on numerous occasions by way of invisible assistance and technological information for the Ground, Maritime and Air Self Defense Forces.

Such improvements of technology were sought after in post-war Japan not only in the area of defense, but also in all other areas and industries. In this way, American military technology contributed directly and indirectly to improving technological capabilities in general in Japan. For instance, commercial mill specifications, the standards for military specifications for various equipment and parts designated by the United States Forces, were used as a goal to reach top-notch technological standards of the world, regardless of whether such products were to be delivered to the Defense Agency. We can observe many examples today where parts surpassing these standards are produced at low cost. The mill specifications have been developed not by mere impromptu ideas, but by defining numerical values based on the accumulation of numerous practical experiments and technological test data. It would not have been easy to develop any one such specification in Japan.

It is true that such assistance by the United States has, in various ways, been provided by placing Japan in the middle of conflicts between the United States and the Soviet Union and as proof of the Japan-U.S. alliance based on the Japan-U.S. Security Treaty. However, owing to American assistance, Japan has maintained an extremely low defense budget, something that is rare in the world, with minimum defense efforts, i.e., only 1 percent of the GNP for defense spending and around 2.5 percent of related research and development expenditures, and has grown into an economic giant by allotting extra power for economic growth as helped by the diligence of the people. Even though the relationship between Japan and the United States has, in this way, been built on the mutual interests of the two nations, Japan owes the United States in a general way, and an irresponsible attitude, i.e., that defense efforts can be left up to someone else, has been cultivated in Japan, leading to a lack of perception with regard to national defense. Needless to say, the United States is not to be blamed for this. Naturally, although it must be considered and dealt with by the Japanese people and the Japanese government, the rest of the world is paying attention to it.

Even though the threat of the Soviet Union has disappeared, a minimum defense effort is still necessary, together with other types of efforts such as diplomacy, to cope with the unstable factors that exist in the Asian-Pacific region. Adherence to the Japan-U.S. security system is becoming even more important for Japan, which does not possess the means to defend itself from strategic arms that can fly instantly from outside Japanese territorial soil, waters and airspace. In short, Japan's defense still cannot be implemented without coordination with the United States. An important issue from now on will be how deeply that aspect can be analyzed, and to reflect it in governmental policy with the broad support of the people.

3. Need for Japan-U.S Technological Cooperation

With respect to implementing Japan's defense, at least by the world's standards, based on the Japan-U.S. security system and with the decline of the relative economic power of the United States, there are a number of problems, in addition to the issue of the Constitution of Japan, with its execution. Japan's defense has not attained the minimum fundamental military functions possessed by an ordinary nation. These problems are in a different dimension from the tactical training and achievement accumulated as a result of continuous effort on the forefront, and can be roughly divided into functional defects in the strategic phase, items that cannot be implemented due to legal restrictions, and items that can be more or less executed if sufficient time is spent, but will not be functional in urgent situations.

For instance, concerning strategic functions, since Japan does not possess a military information network on an international scale, one must be provided by the United States. Japan is still dependent on the United States in such aspects as supplying parts for American arms and strategic transportation from the continental United States quickly during an emergency, the communication of strategic information by way of reconnaissance satellites and communications satellites of the United States in urgent situations, the U.S. nuclear umbrella in the event of threat by nations with nuclear arms, and the presence of U.S. forces to prevent invasion. It will continue to be difficult for Japan to execute such functions independently. It is important to analyze the status of these strategic issues owing to the long-term effort of

the United States and in order to gain the mutual understanding of the peoples of both nations. The American people will reconsider whether or not they, experiencing difficulties, should pay taxes to contribute to Japan, the economic giant.

Although legal restrictions must be discussed and determined by the Japanese, naturally they will have to be modified according to international conventions if Japan is to be accepted by international society. The designation of moderate legal systems from the military standpoint requires research and analysis of the military perspectives as well as coordination with the United States. For the time being, sufficient discussion with the United States concerning issues based on legal restrictions is necessary.

The May 1993 experimental firing of "Labor-I," North Korea's ballistic missile, in the Sea of Japan increased its range to 1,000 kilometers. It will only take a few minutes to reach Tokyo. Since ballistic missiles drop suddenly and sharply from a point above the sky, it is difficult to catch them with the naked eye, or even with radar. Under the current conditions in Japan, it will take several hours to analyze the situation on the governmental level, and several hours longer to come up with ad-hoc measures. If ballistic missiles are shot continuously, without mercy, at an interval of several minutes, Tokyo will be in a panic, unable to take any countermeasures. The modern Japanese people do not really want to think seriously about such a thing. However, since trial firing has actually been executed, the probability of [the above scenario] taking place is several hundredths of one percent. The prevention of such an event by diplomatic negotiations may not succeed under the worst case conditions, and extremely disadvantageous conditions may be forced on Japan. Having a defense means to present responsible policy by keeping the worst case conditions in mind, which must be clearly distinguished from preventing the uncontrolled maneuvering of military power. It must be broadly understood by the people at large. In conclusion, the relationship between Japan and the United States must be reinforced more than ever before since governmental measures for emergency and crisis control involving different sections and ministries require a considerable amount of time and lack strategic and military information, even if those in charge of defense make serious efforts in their designated positions.

Therefore, this paper is concerned with the issue of how the alliance between Japan and the United States should be maintained. The alliance could not have existed in the first place if there had not been an advantage on the part of the United States. The alliance has more or less been maintained due to Japan's location between the United States and the Soviet Union, who were in conflict. Now that the Soviet Union does not exist, other nations that create unstable factors in Asia cannot actually represent a direct threat to the United States. The missiles of North Korea, however improved, cannot reach the continental United States.

During the past half century, the United States has continued to implement policy to attain military superiority over the former Soviet Union by carefully nurturing science and technology. Research on the Strategic Defense Initiatives (SDI) started in 1983 by ex-President Reagan produced various partial results and triggered the collapse of the Soviet Union by clearly demonstrating the superiority of American military technology without the ultimate production and distribution of arms.

The United States has requested the cooperation of Japan, with her improved economy and technology, in the area of military technology based on the belief that the development of technological power is still indispensable. The overall technological difference between Japan and the United States today is thought to be more than one hundred times. In the United States, massive spending for research in military technology has been invested and technological results have been accumulated in various well organized governmental research and development organizations, while Japan has barely continued military research. However, careful examination of individual technological fields indicates that Japan is superior in some electronic technology and material technology. It is also believed that the United States is superior in system technology, while Japan is superior in some parts technology. Concerning production technology in general, Japan is superior with respect to economy and reliability.

Although there are not many technological fields in which Japan can take charge, proper technological cooperation can be the most important factor contributing to maintaining the Japan-U.S. security system. From now on, it will be necessary to examine individual technological content. If technological cooperation concerns a certain ministry, such as the Defense Agency, the Ministry of International Trade and Industry, the Ministry of Foreign Affairs, etc., it will be necessary to cope with it by means of strategic thinking beyond the interests of the ministry, for instance, by establishing dedicated research teams directly under the cabinet to determine what kinds of legal issues exist and how to approach private enterprises with such technologies.

4. Current Status of Technological Cooperation Between Japan and the United States

When technological cooperation is considered in detail, we tend to lose the entire image, focusing instead on procedural discussion such as the definition of technology and the range of cooperation. Although it is important to determine definitions and ranges, in this paper, the term technology indicates not only products, but also ideas and know-how. It includes ways of thinking to create new capabilities, corresponding to the English word "technology," rather than production techniques. Cooperation indicates the mutual exchange and sharing of values that are considered approximately equal. However, technological values often remain undetermined and flexibility is required when evaluating them.

Figure 1 [not reproduced] illustrates the interchange of military technology between Japan and the United States from a historical perspective. From 1945-1954, gratuitous arms and equipment were provided by the United States. When new technology was included in them, top-level products were provided in onerous assistance and the debt was returned by payment. While DEA is the exchange of technological information based on memorandums, in principle information flows more from the United States than from Japan. Licensed production refers to production in Japan according to design specifications bought from the United States based on agreements. Although there are many conditions that cannot be changed in Japan, new types of technology can be very stimulating.

The Japan-U.S. regular meeting for equipment and technology (S&TF) is held once a year to strengthen the cooperation of the defense authorities of Japan and the United States. Such topics as Japan-U.S. cooperative research, onerous assistance and licensed production have been discussed. In 1983, the transfer of military technology to the United States based on the Japan-U.S. Security Treaty became possible through exemption from the three principles for arms export. So far, such technologies as portable SAM, shipbuilding and repair, fighter support experimental (FSX), a digital flight control system for the PC3, etc., have been provided. Cooperative research includes such themes as ducted rocket engines, ceramic engines for tanks, millimeter wave-infrared compound seekers, closed loop demagnetization, advanced steel materials for warships and armed vehicles, and eye-safe lasers for examination and promotion by working committees. FSX is the first case of cooperative development and, following a number of discussions, has been implemented with Japanese funds.

In addition, in the past year, the United States has proposed cooperative research and development for theater-of-war missile defense (TMD) and the transfer of dual-use technology (DUT) to the United States. TMD is intended for defense from mid-range ballistic missiles, which is lacking in the Japanese defense system. Although the issue has been covered under the nuclear umbrella of the United States, it has newly arisen against the background of the reduction of the nuclear umbrella, the development of missiles in North Korea and Japan's economic growth. The initial proposal by the United States included the transfer of TMD technology from the United States in exchange for comparable Japanese DUT. In the meantime, the technological contents of TMD are being studied and examined since it is difficult to relate DUT directly to TMD and, therefore, it is to be studied separately. If the research and development of TMD is implemented by Japan and the United States in cooperation, since TMD consists of many systems, it could give a number of technological stimuli to the Japanese defense industry. It is possible that a number of cases will arise in which highly advanced American interceptor missiles can be purchased, communications networks newly developed partially also using Japanese DUT, and command and control systems can be developed combining American software and Japanese hardware.

5. Concrete Responses of Japan

In order to maintain the Japan-U.S. security system, it is necessary to clarify what we are asking the United States to do for Japan and what Japan can contribute. It is desirable that the two portions of mutual work be equal in value. Although a number of measures, such as cooperative maneuvers by the two nations, the interoperability of arms and equipment, and the payment of expenses for the United States forces in Japan, can be taken, the most important issues for the United States today are the maintenance of military technology with declining military expenditures, the reorganization of the defense industry infrastructure, and the effective commercial use of accumulated military technology, etc., all of which concern fundamental technological issues. The United States proposes, among other things, paying attention to Japanese DUT, acquiring its innovative ideas and economical production technology, and using them in the development and production of various arms systems. In such a case, it would be relatively easy to consider the transfer of Japanese DUT to the United States if the products of an arms system collaborated on by the Defense Agency and private enterprise are initially developed for commercial use by the enterprise.

However, many items of DUT desired by the United States are totally commercial products unrelated to the Defense Agency, and the transfer of such technology is a matter of commercial consideration for enterprises. There are two cases, depending on who the customers are, as described in Figure 2. One is the relationship between one enterprise and another enterprise, which can be considered ordinary DUT transactions of DUT for military purposes. The other case is the relationship between a Japanese enterprise and the U.S. Department of Defense. Since there are a number of governmental arsenals and research organizations under the Department of Defense, DUT is expected to be used there first and then, in some cases, transferred to enterprises. In the latter case, the point that is more important than ordinary transactions is that the transfer of DUT to the United States be implemented to maintain Japan's security, for instance, in return for the nuclear umbrella. Then, it is natural that various agreements related to the DUT transfer be endorsed by the Japanese government in order for enterprises to initiate it voluntarily.

Furthermore, although the economic loss resulting from DUT transfer is to be compensated for by the U.S. Department of Defense in principle, relief measures such as supplementation by the Japanese government, financing of research and development costs, partial exemption from corporate taxes, etc., are necessary. In the United States, there are sufficient items for technological interchange which are produced through governmental investments, including those by the Department

of Defense and Department of Energy. However, since such examples are extremely rare in Japan, it is necessary to consider purchasing defense technology.

If such treatment of DUT becomes possible even though the current laws and regulations do not permit it, it will be necessary to reconsider the legal system in the Diet to check whether or not Japan's national interests are being damaged due to the current system. Since there has been, for a long time, a strong trend toward a vertical way of thinking in both governmental and private organizations in Japan, there should be an organization to examine policies for important issues involving national strategies, maintaining an equal distance from the Defense Agency, the Ministry of International Trade and Industry, the Ministry of foreign Affairs, etc. It will also be necessary to develop a strategic analysis group that can exchange actual intentions freely with the United States prior to policy decision and sufficiently examine the fundamental technological contents.

6. Conclusion

The policy for technological cooperation is considered extremely important in establishing a Japan-U.S. alliance based on the Japan-U.S. security system. Technology has been considered supplementary to security in Japan. This is exactly the point where the United States and other foreign nations differ somewhat in value judgment. In the United States, technology is the invisible origin of fighting power and the constant motive for developing into the future. The creation of technology is considered the most important issue. In Japan, on the other hand, technology is something provided by advanced nations rather than something to create on its own. Japan is interested in copying the technology to manufacture marketable products, in other words, her interests are directed toward innovation, mass production and cost for procurement.

Although those in charge are passionately engaged in the current issues, the situation requires internationally sensitive responses as Japan's position improves. Just as technological cooperation cannot be implemented without fully understanding technological contents, it is equally vital to fully understand the differences in concepts about cultures, traditions and technology from nation to nation. It is necessary for the Japanese to device a method to maximize the contribution of Japanese technology to Japan's security.

NTT vs. NCCs; What Is the Technique for Wisely Selecting a High-Speed Digital Transmission Service?

94FE0494A Tokyo NIKKEI COMMUNICATIONS in Japanese 21 Feb 94 pp 96-109

[Article by Yasukazu Tsuchiya]

[Text]

- **On 1 February, NTT's rates for high-speed digital transmission services dropped. The current rates are less than half of what they were when the service was started in November 1984, and the content has improved so much that the service does not even resemble what is was before. For corporate subscribers, using such services has become increasingly more economical.**
- **The NCCs (New Communications Companies) have not been beaten. By setting their rates lower than NTT's, NCCs are working hard to get new customers. Local NCCs are appearing in the areas that used to be "blank spaces"—Chukoku, Tohoku, and Hokuriku—as NCCs continue to set up an environment for competition with NTT. Here, I will compare NTT with NCCs.**

High-speed digital transmission services (high-speed digital lines) are becoming increasingly essential as the basic lines of today's corporate information communications networks. The growth in the number of lines that have opened attests to that. The number of lines increases constantly, at a high rate of some 30% per year (Figure 1). The fact that rates have steadily dropped is another big factor in the gain in momentum in the usage of high-speed digital transmission lines. On 1 February NTT reduced its rates by an average of 10%. The result of that fifth rate reduction since NTT started high-speed digital transmission service is that NTT's rates are down to about one-half or one-third of the initial rates when the service started. For subscribers, using the communications services has become increasingly more economical.

On the other hand, we cannot overlook the existence of NCCs. After the "communications liberalization" of 1985, the succession of NCCs that appeared set their rates several to tens of percentage points below NTT's rates, and they have strived to distinguish themselves from NTT by further subdivisions of their long-distance demarcations. Those efforts became the trigger for NTT's rate reductions and led to an increase in the NCCs' share of the market, while at the same time the overall scale of the market for high-speed digital lines expanded (Figure 1).

Furthermore, over the past year or two, the NCC service base has continued to improve. For example, long-distance NCCs providing trunk lines expanded their service areas until they covered almost all of Japan. Local NCCs, which bring their own lines into subscribers' officesto provide end-to-end service, also continue to eliminate the "blank zones" of the past. Chukoku Communications Network started providing a high-speed digital transmission service on 1 October 1993. Tohoku Intelligent Communications plans to start such service in June 1994, and Hokuriku Communications Network in October 1994.

Next, I will compare the high-speed digital transmission services of NTT and the NCCs, who continue to build an environment for competition.

Rates, NCCs' Strategy; Service Areas, NTT's

Table 1 gives a rough comparison of NTT's and the NCCs' high-speed digital transmission services. It may just be easier to grasp the overall picture if we remember that "the NCCs have lower rates, and NTT's service areas cover all of Japan."

Table 1. Rough Comparison of NTT's and NCCs' High-Speed Digital Transmission Services

NTT	NCCs
• Overall, higher rates than the NCCs (less difference in rates after NTT's 10% average rate reduction after 1 February)	• Rates are lower than NTT's
• Along with that rate reduction, long-distance demarcations will be further subdivided to meet subscribers' needs	• Some local NCCs counter NTT with their own distance demarcations
• All-NTT end-to-end lines can be configured . also seen as advantageous in operations maintenance	• When long-distance NCCs are used, another company's lines from the POI (point of interconnection between NCCs or between NTT and an NCC) to the subscriber and vice versa are usually needed
• Implementing a centralized customer service window for reporting faults, etc	• Long-distance NCCs' service areas cover all of Japan except Okinawa (TWJ is expanding its service to all of Japan)
• Now trying out a total operations maintenance service with other communications services such as ISDN and packet networks	• Local NCCs are confined within the boundaries of the local electric power company's business territory (igure 2), interconnections between local NCC systems are not possible
• Service regions cover all of Japan	• Now augmenting their consulting work
• Many employees. "A little more experienced" in consulting, too?	• Some local NCCs provide their own service items (CTC's 2-Mbps and 32-Mbps lines)
• Provides 150-Mbps private lines within city limits	• Only long-distance NCCs and some local NCCs offer discounts for heavy-volume usage and for long-term continued usage

Table 1. Rough Comparison of NTT's and NCCs' High-Speed Digital Transmission Services (Continued)

NTT	NCCs
• Set up a new "6-year contract, 11% discount" in the discounts for long-term continued usage	• In long-distance NCCs, there are wide-area wireless services that do not use POI-to-subscriber lines
• The basis of the networks is optical fiber, but 64-kbps and other such low-speed services are provided through metallic cable	• 64-kbps and other such low-speed services also provided through optical fiber (TTNet and CTC)

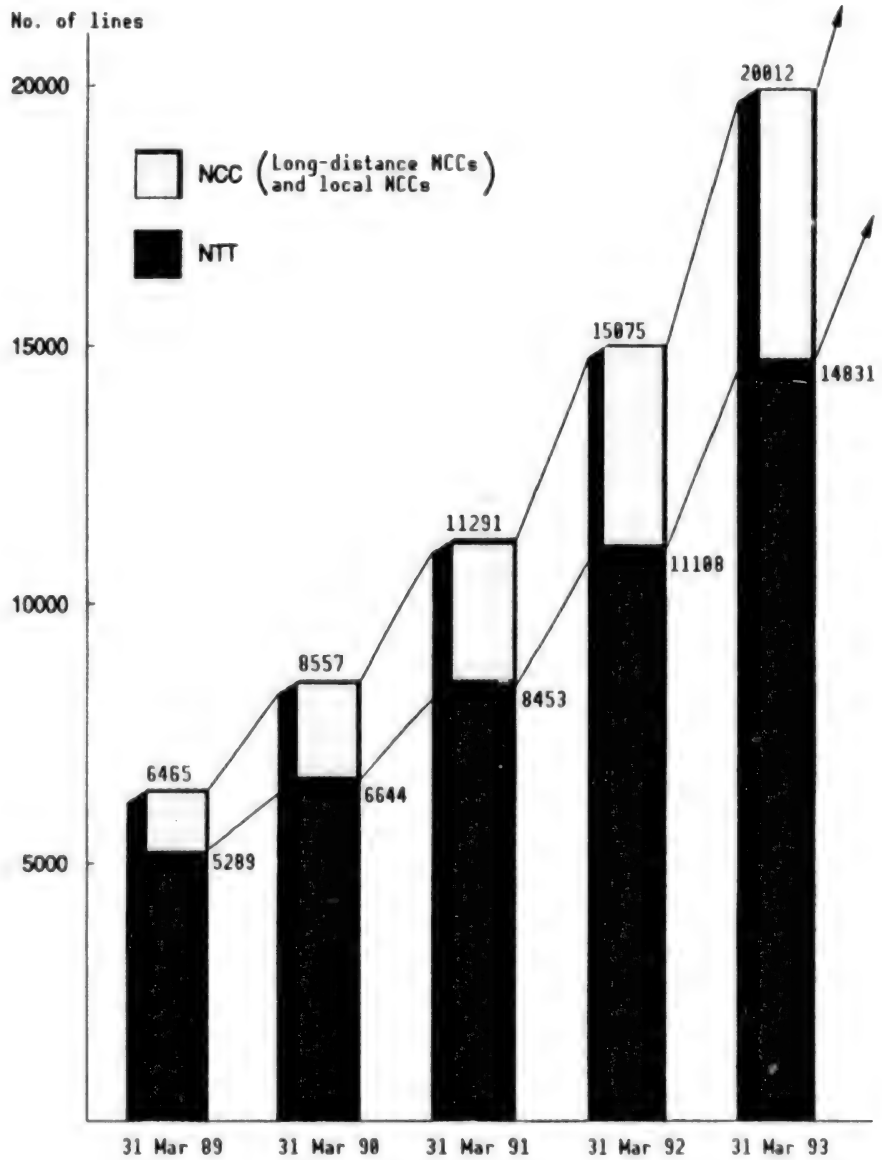


Figure 1. Changes in Total Number of High-Speed Digital Transmission Service Lines (Based on a report of the Association of Telecommunications Companies (1992) and NTT data)

Details about the rates will come later, but in general the NCCs charge less than NTT. However, with NTT's rate reduction that went into effect 1 February, the differences in rates are smaller, and, depending on the conditions, NTT's rates are sometimes lower.

In view of service areas, we can say that NTT has the advantage. Due tothe facts that the NCCs are divided into long-distance NCCs and local NCCs and that they started providing service later than NTT, among other reasons, the NCCs have not yet reached the point where they cover every corner of Japan.

What about service items? NTT and the NCCs are just about the same on this point. (NTT offers 150-Mbit/sec lines within city limits, and Chubu Telecommunications independently provides 32-Mbit/sec lines within its service area, but those are exceptions because there are no capabilities for linking two arbitrary points that span across Japan.) There are two subscriber-network interfaces in high-speed digital transmission services—NTT's original "Y interface" and the international standard "I interface"—that are subdivided into 12 items according to speed (64 kbs to 6 Mbps). The NCCs, and NTT, of course, offer both the Y and I interfaces.

NCCs Divided Into Long-Distance Systems and Local Systems

First, I will give a breakdown of the NCCs. This is closely tied to the NCC's rates for high-speed digital transmission service and the service areas.

NCCs are divided into long-distance NCCs, which provide trunk lines, and local NCCs, which bring their own lines to subscribers' offices to provide end-to-end service.

Three companies are long-distance NCCs: Japan Telecom (JT), Daini Den Den (DDI), and Japan High-Speed Communications (TWJ). JT and DDI now service all of Japan except for Okinawa. TWJ plans to complete its nationwide coverage in 1994.

High-speed digital transmission lines will become configured so that they certainly link two points end to end, but long-distance NCCs can only provide the trunk-line portion of that sort of link. Thus, long-distance NCCs must use NTT or local-NCC lines as POI-to-subscriber and subscriber-to-POI lines.

Local NCCs, on the other hand, now include nine companies[Note]: 1) Tokyo Telecommunications Network (TTNet), 2) Osaka Media Port (OMP) 3) Chubu Telecommunications (CTC), 4) Kyushu Telecommunications Network (QTNet), 5) Shikoku Information Telecommunications Network (STNet), 6) Hokkaido Overall Telecommunications Network (HOTnet), 7) Chukoku Telecommunications Network (CTNet), 8) Tohoku Intelligent Telecommunications (TOHKnet), and 9) Hokuriku Telecommunications Network (HTNet) (see Figure 2).

Local NCC service areas are confined within their respective regions. To be exact, a local NCC's territory is the same as that of the area's electric power company that finances the local NCC. The local NCC can provide high-speed digital transmission service only within its territory (Figure 2).

There is also an area where high-speed digital transmission services cannot be used. That is Okinawa, which has no local NCC. And, becausethe local NCCs started service long after NTT, there are still some areas where network facilities have not been constructed. The criterion for each local NCC's service area is the "rate of coverage for businesses with 30 or more employees." TTNet, OMP, and CTC, who started providing service before the other local NCCs, cover more than 90% of their local businesses with 30 or more employees.

Five Forms of Connection

That sort of division into long-distance NCCs and local NCCs complicates the topic of "NTT vs. NCCs": when a subscriber introduces a high-speed digital transmission line, there are five forms from which to choose (Figure 3).

First, there is the form of connection in which only NTT is used ((1) in Figure 3).

Then, there is the use of a long-distance NCC's line as the trunk line part of the connection, and the use of local NCC lines for both the POI-to-subscriber line and the subscriber-to-POI line ((2) in Figure 3). Or, NTT can be chosen for the POI-to-subscriber line and/or the subscriber-to-POI line ((3) in Figure 3). These configurations became possible because long-distance NCCs and local NCCs, and long-distance NCCs and NTT reached agreements on interconnections in high-speed digital transmission services. The points of interconnection, called POIs, form the boundary points for charges, services, etc. (See Tables H and J in the data section following the article).

Furthermore, networks can be configured with only long-distance NCC lines, and without using a local NCC or NTT for the POI-to-subscriber and/or subscriber-to-POI lines ((4) in Figure 3). That special case is called "wide-band wireless service" (discussed later).

Finally, a configuration in which only a local NCC is used is possible. That is limited to cases where two points connected with high-speed digital lines are within the service area of one local NCC ((5) in Figure 3).

The charges are linked to these forms of connections and are calculated by simply adding the charges for the trunk-line service to the charges for the POI-to-subscriber line and the subscriber-to-POI line.

All NTT vs. All NCC

Of the five forms of connection, the first one, all NTT, and the second one, all NCC, are the most competitive in terms of charges. The conclusion is that the cost-merit comes out for subscribers if they choose the all-NCC form of connection.

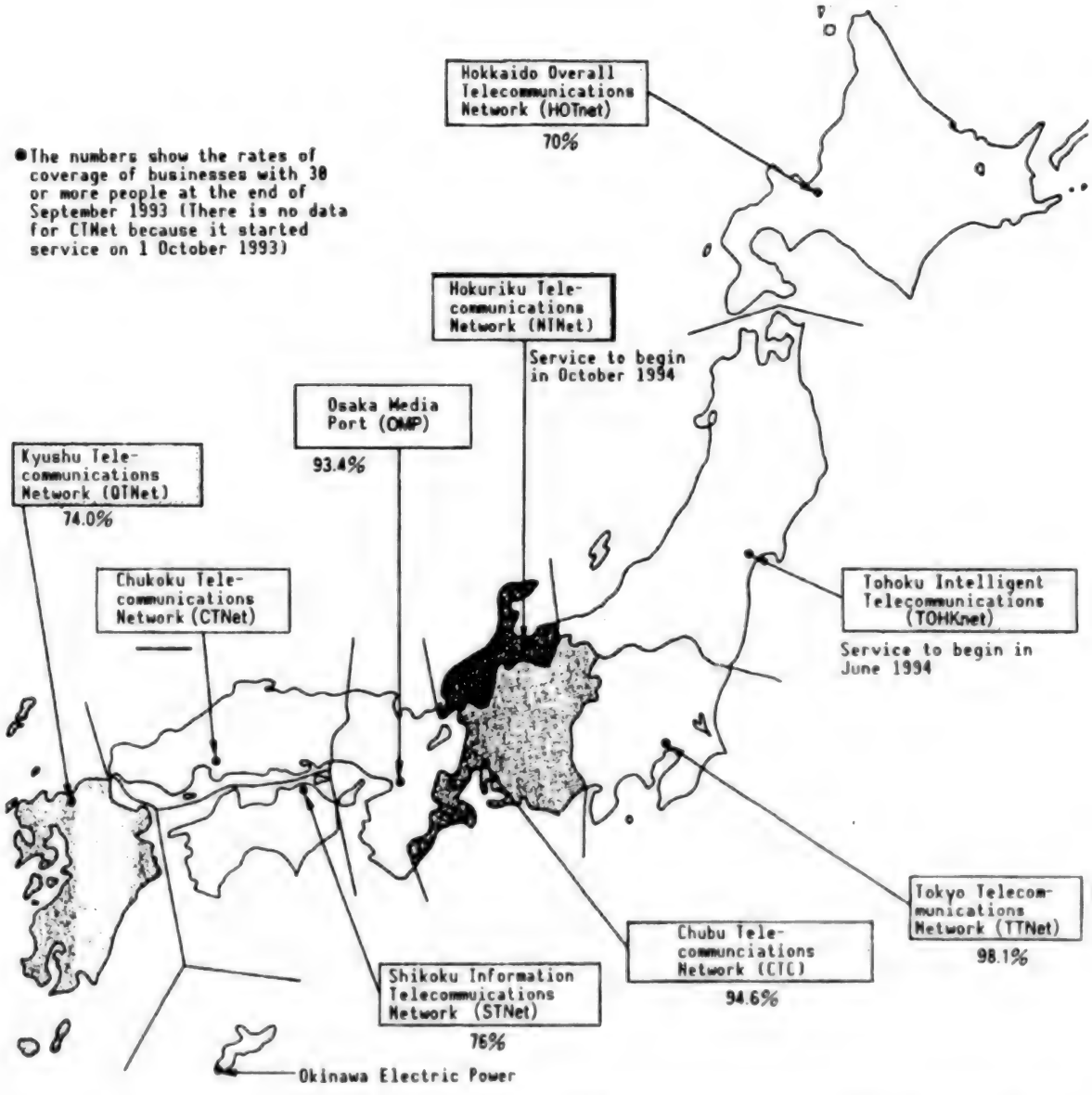
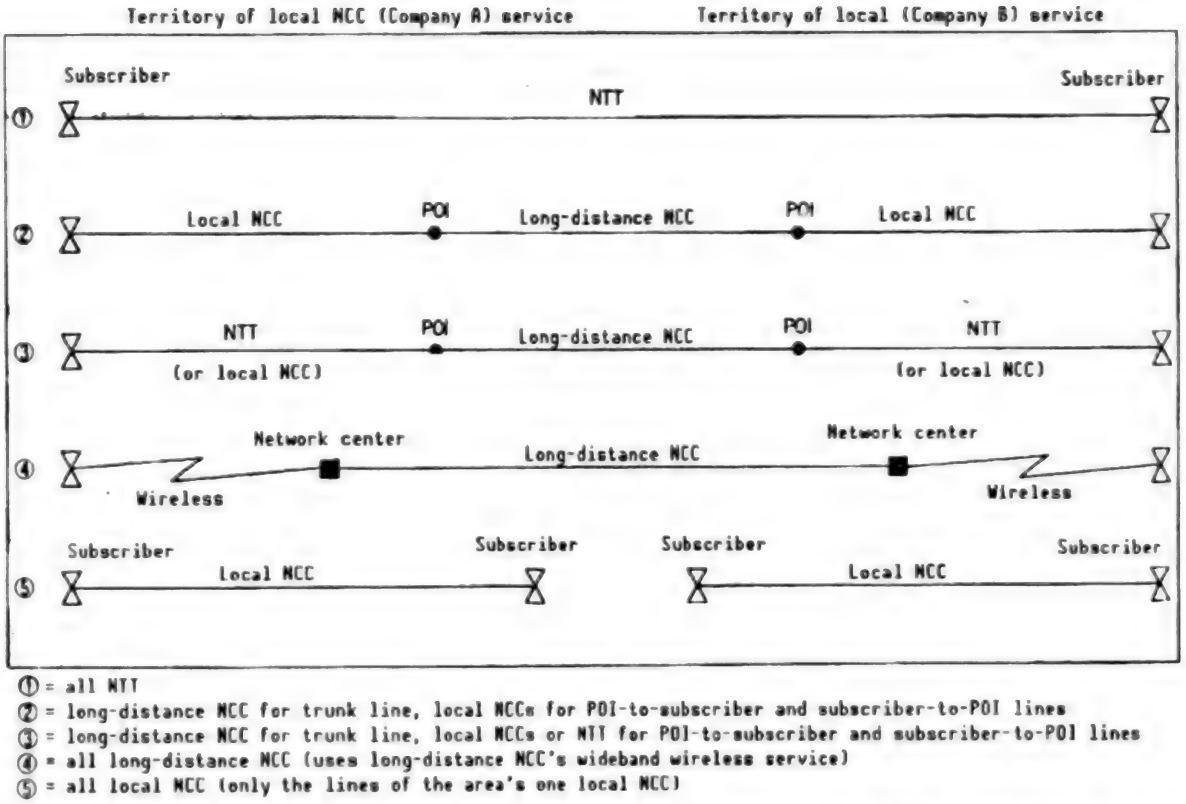


Figure 2. Territories of the Nine Local NCCs. The local NCCs' territories match those of each region's electric power company. Chukoku Telecommunications Network (CTNet) started high-speed digital transmission service on 1 October 1993. Tohoku Intelligent Communications plans to start such service in June 1994, and Hokuriku Communications Network in October 1994.



① = all NTT
② = long-distance NCC for trunk line, local NCCs for POI-to-subscriber and subscriber-to-POI lines
③ = long-distance NCC for trunk line, local NCCs or NTT for POI-to-subscriber and subscriber-to-POI lines
④ = all long-distance NCC (uses long-distance NCC's wideband wireless service)
⑤ = all local NCC (only the lines of the area's one local NCC)

Figure 3. Forms of Connections in High-Speed Digital Transmission Services. The most prevalent forms of connections are (1) all NTT; (2) long-distance NCC lines used for the trunk lines, and local NCC lines for POI-to-subscriber and subscriber-to-POI lines; and (5) all local NCC lines (only the local communications company's lines). POI stands for "point of interconnection."

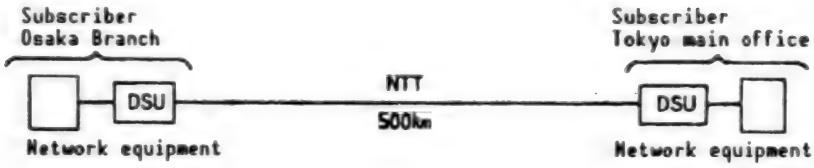
Figure 4 shows a concrete rate simulation for the case where a high-speed 1.5-Mbps digital line is laid between Tokyo and Osaka. The charges for setting up new all-NCC service are ¥40,000 lower than for all-NTT connections. The all-NCC monthly charges (basic line charge) are also ¥50,000 lower. Because subscribers usually sign at least a one-year contract for high-speed digital transmission service, that comes to a total ¥600,000 difference between all-NCC service and all-NTT service. "Now, with the recession and the need for reducing expenses, we cannot ignore that difference," says a spokesman for a large service company.

Subscriber-to-POI Distance Important

However, it must be noted that the monthly charges are computed for subscriber-to-POI distances up to 15 km in both Tokyo and Osaka. The basic line charges for high-speed digital transmission service increases in stages as the distance increases (Table E). The difference in basic line charges for "15 km or closer ' and then "30 km or closer" is large.

From Table 2, the cost-merit of all-NCC in comparison with all-NTT only shows up in the cases where both the POI-to-subscriber line and subscriber-to-POI line are "15 km or closer." If the subscriber-to-POI line on either the Tokyo side or the Osaka side is in the category "30 km or closer," all-NCC service will be more than 10% higher than all-NTT service. If the subscriber-to-POI lines on both sides are in the category "30 km or closer," all-NCC service will be up to 30% higher than all-NTT service.

(1) All NTT used



● Charges for setting up new service

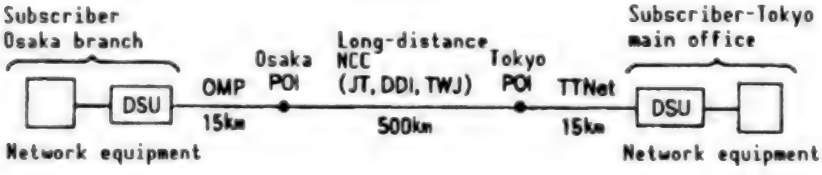
NTT facilities and equipment burden charges	¥102,000 × 2	=¥204,000
// charges for engineering work	¥ 21,000 × 2	=¥ 42,000
		¥246,000

● Monthly charges

NTT basic line charge (up to 500km)		¥2,696,000
// wiring equipment charge	¥ 2,000 × 2	=¥ 4,000
// circuit connector charge	¥19,000 × 2	=¥38,000
		¥2,738,000

(2) All NCC used (long-distance NCC for trunk line, local NCCs for POI-to-subscriber and subscriber-to-POI lines)

NCC)



● Charges for setting up new service

TTNet facilities and equipment burden charges		¥102,000
// charges for engineering work		¥ 25,000
// charges for POI connection work		¥ 1,500
Long-distance NCC's charges for POI connection	¥1,000	×2=¥2,000
OMP facilities and equipment burden charges		¥ 50,000
// charges for engineering work		¥ 23,500
// charges for POI connection work		¥ 2,000
		¥206,000

● Monthly charges

TTNet's basic line charges (up to 15km)	¥308,000
// wiring equipment charge	¥ 2,000
// circuit connector charge	¥ 19,000
Long-distance NCC's basic line charges (up to 500km)	¥2,040,000
OMP's basic line charges (up to 15km)	¥298,000
// wiring equipment charge	¥ 2,000
// circuit connector charge	¥ 19,000
	¥2,688,000

Figure 4. Simulation of Charges When 1.5-Mbps Tokyo-Osaka Line is Leased. For the case where all NCC lines are used, the distances of the Osaka and Tokyo POI-to-subscriber lines and subscriber-to-POI lines are 15 km.

Table 2. Basic Monthly Charges for All-NCC Service Between Tokyo and Osaka

Long-distance NCC used for trunk line. Long-distance NCC charges are the same for JT, DDI, and TWJ. On the Tokyo side, TTNet is used for the subscriber-to-POI line; on the Osaka side, OMP. If the subscriber-to-POI distance exceeds 15 km, all-NCC service will be more expensive than all-NTT service.

Item		64 kbps	128 kbps	192 kbps	256 kbps	384 kbps	512 kbps	768 kbps	1 Mbps	1.5 Mbps	3 Mbps	4.5 Mbps	6 Mbps
All-NTT service		345	530	705	865	1,070	1,320	1,710	2,220	2,700	4,190	5,490	6,660
Long-distance NCC as trunk line													
TTNet 15-km range	OMP 15-km range	334 (97%)	510 (96%)	660 (94%)	808 (93%)	1,032 (96%)	1,283 (97%)	1,660 (97%)	2,180 (98%)	2,650 (98%)	4,125 (98%)	5,410 (99%)	6,590 (99%)
TTNet 15-km range	OMP 30-km range	388 (112%)	602 (114%)	780 (111%)	954 (110%)	1,226 (115%)	1,517 (115%)	1,905 (111%)	2,499 (113%)	3,005 (111%)	4,765 (114%)	6,240 (114%)	7,550 (114%)
TTNet 30-km range	OMP 15-km range	384 (111%)	595 (112%)	769 (109%)	941 (109%)	1,211 (113%)	1,489 (113%)	1,920 (112%)	2,529 (114%)	3,060 (113%)	4,760 (114%)	6,270 (114%)	7,580 (114%)
TTNet 30-km range	OMP 30-km range	438 (127%)	687 (130%)	889 (126%)	1,087 (126%)	1,405 (131%)	1,723 (131%)	2,165 (127%)	2,848 (128%)	3,415 (127%)	5,400 (129%)	7,100 (129%)	8,540 (128%)

Note: The numbers within parentheses are the (rounded-off) percentages of all-NTT charges. "bps" is an abbreviation for "bits per second."

This trend is not limited to Tokyo-Osaka connections; it is typical when all-NCC service is used (Figure 5). Although it is an extreme case, here is a good example: TTNet's and CTC's service areas are to the east and west, respectively, of the Fuji River of Shizuoka Prefecture. One subscriber with a high-speed digital line is located right next to the river (in TTNet's service area), and the other subscriber is right next to the other side of the river (in CTC's service area). Although the distance between the two subscribers is as far as a stone's throw, to use all-NCC service one must set up a long line to TTNet's POI with the long-distance NCC, and the other to CTC's POI with the long-distance NCC (Table 1). Then, the POIs are linked by a long-distance NCC. If NTT is used, there is a direct link between the two subscribers, and the distance is shorter. Because of the current system of charges, NTT wins out over the NCCs.

With NTT's Rate Reductions, A Reversal

What about cases other than all-NCC service? In the case of (3) in Figure 3, where a long-distance NCC is used as the trunk line and NTT is used for subscriber-to-POI lines, even if the distance of a subscriber-to-POI line exceeds 15 km, the charges are not very different from those for all-NTT service. That is because NTT dropped its rates on 1 February. When NTT did that, it set up new distance demarcations. Because those demarcations

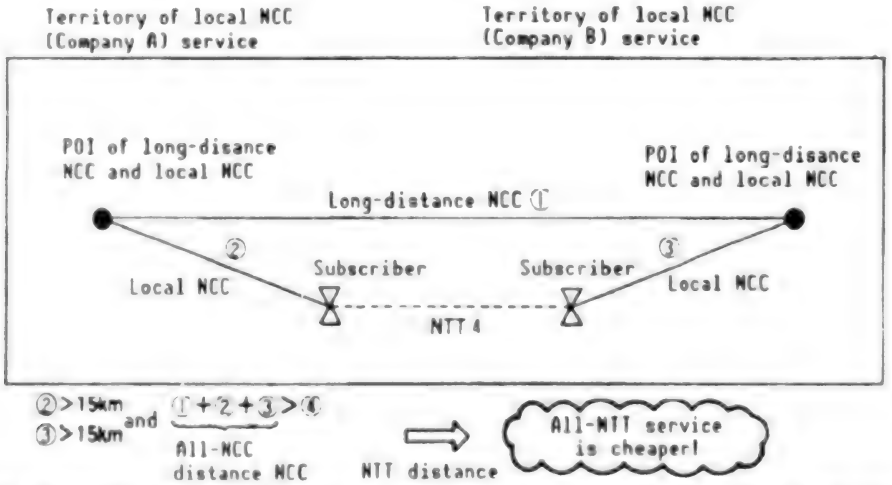


Figure 5. When Subscriber Is Far From the POI, NTT Service Is Less Expensive. Because of the present system of high-speed digital transmission services, when the subscriber is far away from the POI of the long-distance NCC and the local NCC (more than 15 km away), all-NTT service becomes more economical.

are smaller than those of the long-distance NCCs, all-NTT service is a better deal sometimes. For example, in distance categories such as "50 km or closer" and "140 km or closer," all-NTT service is 4 to 5% less expensive.

If wide-band wireless service ((4) in Figure 3) is used, the high-speed digital lines of only one long-distance NCC can be used. However, the charges for the wireless part of the service and the trunk-line part are treated separately and are simply added together. For that reason, the service is considerably more expensive than all-NTT service. Furthermore, wide-band wireless service is not realistic because the service area must be within a 10-km radius of one of the long-distance NCCs' network centers, and other such constraints.

How about the comparison with all-local-NCC service? From Table E in the data section at the end of this article, we know that all-local-NCC service costs up to 10% than all-NTT service.

Differences in Discount Systems

There are very small differences in NTT's and NCCs' facilities and equipment burden charges, charges for engineering work, and other additional charges that subscribers pay every month. The contents of those are given in the data section (Tables A-G). Here, I will examine each type of discount system, the variety of which has increased over the past one or two years.

First, there is the "heavy usage discount system." This discount is only given to subscribers whose total charges for monthly line usage and so forth exceed a certain amount. Whereas NTT gives a discount when a subscriber's total monthly charges are more than ¥5 million, the long-distance NCCs and CTC give discounts for total monthly charges over ¥2 million (Table M).

NTT, long-distance NCCs, TTNet, and OMP offer discounts for "long-term continued usage." When a subscriber uses a service continuously for three years, his basic monthly line charge is reduced by a few percent (Table N). When NTT lowered its rates on 1 February, it tried to distinguish itself from the NCCs by adding "an 11% discount for six-year contracts."

OMP has its own original "multiple-line discount system," in which OMP sets discount rates according to the number of lines a subscriber uses (Table O).

There are also discounts for "multiplexed access service" in I-interface high-speed digital lines. Multiplexed access means that multiple high-speed digital lines set up in the same place are multiplexed on one subscriber-network interface, i.e., a service in which many lines are brought together into one line-connection device. The basic monthly charges are reduced for more than two lines (Table P).

Towards Augmented Business Power

Finally, let's look at the differences in how NTT and the NCCs handle the process from the subscriber's application for a high-speed digital line to the start of service, and their operations maintenance systems. Figures 6 and 7 show the flow charts for NTT and the NCCs, respectively.

In terms of business strength, many think NTT is best. For many years now NTT has been assigning account managers from its Corporate Communications Systems Dept. to customers that are heavy users of its services. That department now covers about 800 companies.

Although NTT may handle an application for line service through a branch's dedicated-line service window, an account manager usually acts as the intermediary. NTT is now looking at increasing the number of account managers in order to augment its business strength. "We are thinking about assigning account managers to the 30,000 companies that spend ¥300,000 or more per month on communications," says an NTTspokesman.

On the other hand, the NCCs receive applications for line service through the service windows of either a long-distance NCC or a local NCC. In reality, however, some say that it is entirely a case where the local NCCs, which bring the lines directly to the subscriber's office, go out and look for subscribers who want to introduce high-speed digital transmission service. "In principal, the long-distance NCC that provides the trunk line becomes the window for customer service, but, depending on the subscriber's wishes, the local NCC may become the window for customer service," says a TTNet spokesman.

Like NTT, the NCCs are actively augmenting their business strength, the first step of which is to "take in" customers. For example, OMP is "increasing its staff so that it can provide network consulting from the subscriber's standpoint."

Usually 3 Months Until Service Starts

How long it takes for service to start after application for the line is an important matter for subscribers.

NTT says that "it generally takes one month in the city, and about three months outside of the city." A spokesman for NTT says, "Even if delivery time is sooner than one month, we want to please the customer. We call it 'flexible delivery time.' We put our greatest effort into service because the NCCs' rates are better than ours."

On the other hand, the NCCs usually aim for one to three months, but there are also cases, as with TTNet, where "everything's O.K. if the optical fiber from the road in front of the subscriber's building is laid within two weeks."

Centralized Window Service for Operations Maintenance

NTT provides a centralized customer service window in its operations maintenance system. For example, when some sort of failure or communications trouble occurs in a large-scale case, such as when a subscriber's dedicated-line network centered in Tokyo is expanded over all of Japan, NTT's Tokyo Dedicated Line Center provides a free service for receiving customer complaints in a

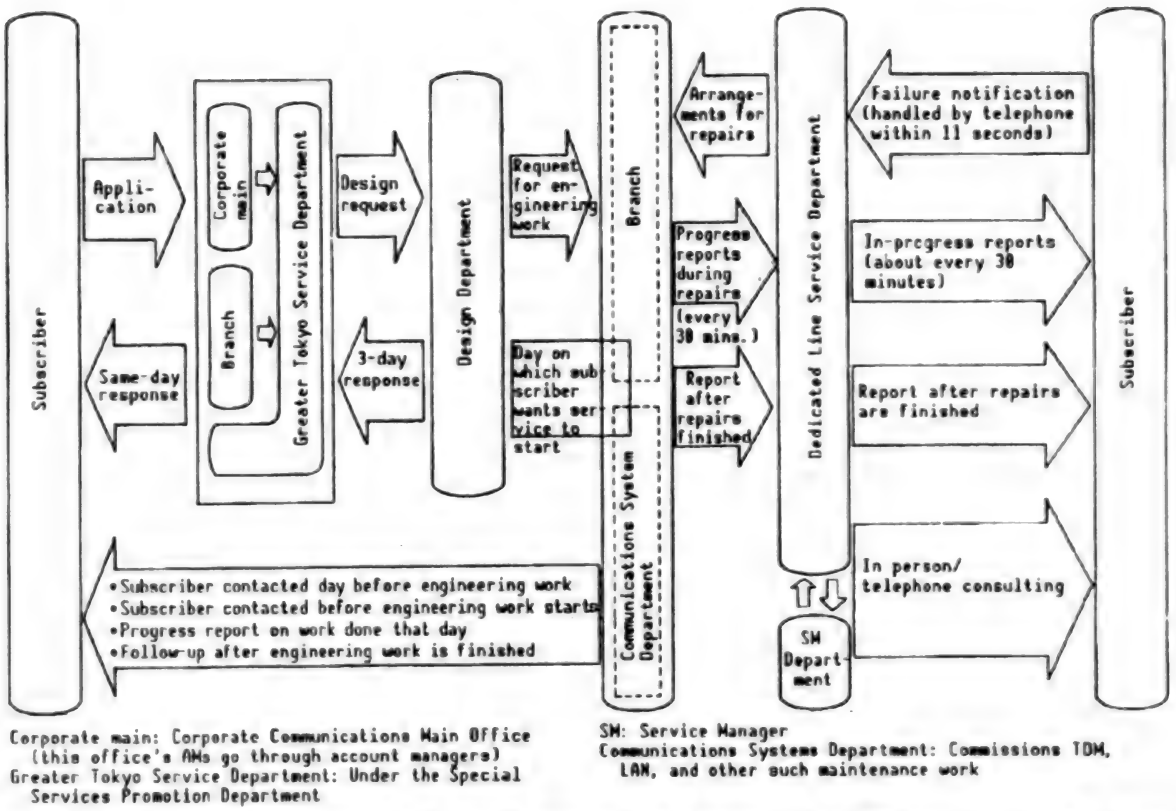


Figure 6. Flowchart From Application for a Line to Operation and Maintenance in NTT. Shown for services within Tokyo, where there are great needs for high-speed digital transmission services. For other regions, the flowchart would be about the same. NTT's Tokyo Dedicated Line Center handles leased-line subscribers within Tokyo (indicated by SOC in the flowchart).

centralized manner. Now, about 130 companies that are heavy users of dedicated lines use the service.

Since October 1992 NTT's Tokyo Dedicated Line Center has also been trying out a "primary use service" through which it centrally maintains communications services for subscribers that mainly use dedicated lines but also use other services such as ISDN and packet-switching services. Four companies now use this service.

As for the NCCs' operations maintenance systems, in principal the long-distance NCCs provide the window for customer service and assume tasks such as receiving customer complaints, arranging for repairs within NCCs, and contacting subscribers about the state of progress of repairs. Incidentally, the NCCs are building a framework so that an alarm will be generated if there is some sort of trouble on a network, and both the long-distance NCCs and local NCCs can track down the problem. Accordingly, investigation of the cause of the problem and restoration work will be done simultaneously and in parallel by long-distance NCCs and local NCCs.

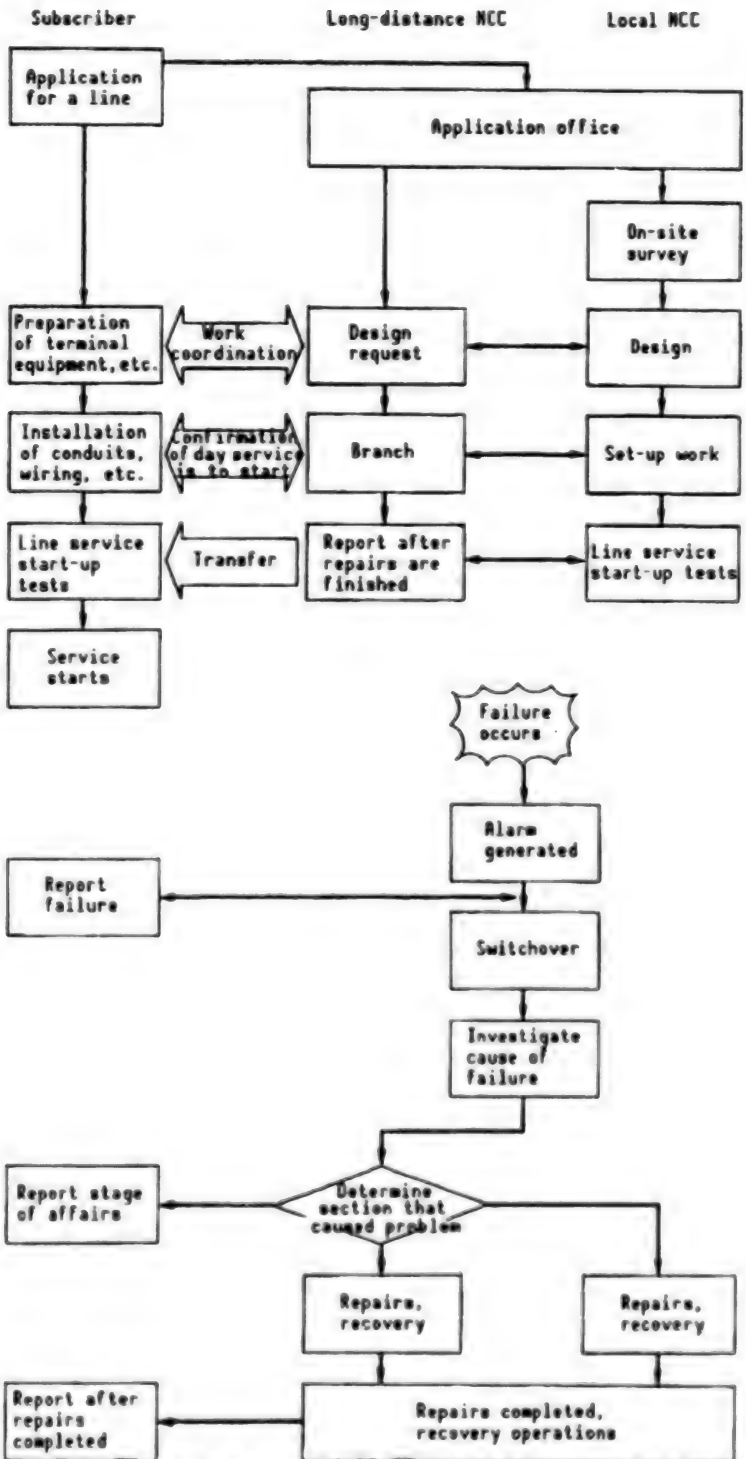


Figure 7. Flowchart From Line Application to Operation and Maintenance in NCCs. When a subscriber opts for all-NCC service (a long-distance NCC for the trunk line, local NCCs for the subscriber-to-POI and POI-to-subscriber lines), he does not have to apply to each NCC separately; only one NCC needs to be contacted about line problems. In principal, the subscriber contacts the long-distance NCC about new service, problems, etc.

Data Section

Table A. Comparison of NTT's and Seven Local NCCs' Facilities and Equipment Burden Charges (for 1 line brought in, 1 circuit) (Unit: ¥)

Company	NTT	TTNet		OMP	CTC		QTNet	STNet	HOTnet	CTNet
64k, 128 kbps	72,000	Metal	72,000	40,000	Metal	20,000	20,000	20,000	20,000	20,000
Optical	102,000	Optical	30,000							
192 kbps - 6 Mbps	102,000	102,000		50,000	30,000		30,000	30,000	30,000	30,000

Note 1: "Metal" means wiring with metallic cable, "optical," wiring with fiber-optic cable.

Note 2: In high-speed digital transmission services, most telecommunications companies provide 64-kbps and 128-kbps services by means of metallic wiring. Services at other speeds (192 kbps - 6 Mbps) are provided by means of fiber-optic cable. However, on 1 June 1993, TTNet and CTC started offering 64-kbps and 128-kbps services by means of both metallic wiring and fiber-optic lines.

Note 3: For CTC, QTNet, STNet, HOTnet, and CTNet, these are the charges for each line that is set up.

Note 4: "bps" is an abbreviation for bits per second.

Table B. Comparison of NTT's and Seven Local NCCs' Charges for New Installation (set-up work for one terminal) (Unit: ¥)

Company	NTT	TTNet		OMP	CTC		QTNet	STNet	H OTnet	CTNet	
I interface	64k, 128 kbps	16,800	Metal	12,500	12,500	Metal	12,000	13,600	12,000	11,500	12,000
Optical	25,000	Optical	20,000								
192 kbps - 6 Mbps	21,000	25,000		23,500	20,000		22,600	20,000	21,000	21,000	
Y interface	64k, 128 kbps	16,800	12,500		12,000	12,000		12,500	12,000	11,500	—
192 kbps - 6 Mbps	21,000	25,000		20,000	20,000		21,000	20,000	21,000		—

Note 1: "Metal" means wiring with metallic cable, "optical," wiring with fiber-optic cable.

Note 2: NTT's engineering charges include the line connection set-up costs (real costs) as equipment set-up costs.

Note 3: CTNet does not provide Y-interface high-speed digital transmission service.

Note 4: "bps" is an abbreviation for bits per second.

Table C. Comparison of NTT's and Local NCCs' Charges for Setting Up a POI Connection with a Long-Distance NCC (for one connection) (Unit: ¥)

Communications company	NTT	TTNet	OMP	CTC	QTNet	STNet	HOTnet	CTNet
All items	2,000	1,500	2,000	3,000	2,000	1,500	2,500	2,500

Note 1: Shows all I-interface, Y-interface services from 64 kbps to 6 Mbps.

Note 2: POI means point of interconnection between NTT, as the local service, and a long-distance NCC, or between a local NCC and a long-distance NCC.

Table D. Three Long-Distance NCCs' Fees for Engineering Work (Unit: ¥)

Type of engineering work	JT	DDI	TWJ
Setting up or moving a dedicated line, changing the service item, changing a direct line to another company, temporary suspension of usage (all charges for these are for each POI)	1,000	1,000	1,000
Branching a dedicated line (for each POI)	2,000	1,000	2,000
Setting up, moving, branching a dedicated line (for one terminal line)[Note 1]	8,000[Note 2]	8,000	8,000
Changing a dedicated-line service item, temporary suspension of usage (for one terminal line)[Note 1]	4,000[Note 3]	4,000	4,000[Note 4]

Note 1: Fees incurred when a direct terminal line is used in wide-band wireless service.

Note 2: The charges that accompany the installation of new line-termination equipment. ¥7,500 for moving a line; otherwise, ¥5,500.

Note 3: The charges for engineering work in connection with changing a service item are ¥4,500.

Note 4: This is the charge for engineering work in connection with a temporary suspension of usage. If no line termination equipment is furnished when changing a service item, the fee is ¥7,500. If line-termination equipment is replaced when changing a service item, the fee is ¥5,000.

Table E'. Comparison of Ranges of NTT's and Local NCCs' Reductions of Basic Monthly Charges for I-Interface Services (Unit: ¥)

Company	NTT	TTNet		OMP	CTC		QTNet	STNet	H OTnet	CTNet
64k, 128 kbps	70	Metal	65	70	Metal	50	—	—	—	—
Optical	2,000	Optical	2,000							
192 kbps - 6 Mbps	2,000	2,000		2,000	2,000		—	—	—	—

Note 1: "bps" is an abbreviation for bits per second.

Table F. Comparison of NTT's and Seven Local NCCs' Special Charges for Wiring Equipment or Service Line Tracks (Unit: ¥)

Company	NTT	TTNet		OMP	CTC		QTNet	STNet	H OTnet	CTNet	
I interface	64k, 128 kbps	60	Metal	65	70	Metal	1,060	260	200	250	260
Optical	2,000	Optical	3,000								
192 kbps - 6 Mbps	2,000	2,000		2,000	3,000		2,500	500	200	2,500	
Y interface	64k, 128 kbps	—	—		—	1,000		200	200	250	—
192 kbps -6 Mbps	—	—		—	1,000		500	500	200	—	—

Note 1: "Metal" means wiring with metallic cable; "optical," wiring with fiber-optic cable.

Note 2: Special charges for wiring equipment are additional charges incurred when the subscriber uses indoor wiring equipment that was installed by the communications company. Special charges for service line tracks are additional charges incurred for wiring equipment between the telephone line pole and the subscriber's MDF (main distribution frame) and protective device. These two may be thought of as the same type of additional charge.

Note 3: CTNet does not provide Y-interface high-speed digital transmission service.

Note 4: CTC's I-interface charges are the sum of the special charges for wiring equipment and special charges for service line tracks.

Note 5: "bps" is an abbreviation for bits per second.

Table G. Comparison of NTT's and Seven Local NCCs' Monthly Charges for Line-Connection equipment (I Interface), Line-Termination Equipment (Y Interface) (Unit: ¥)

Company	NTT	TTNet		OMP	CTC		QTNet	STNet	HOTnet	CTNet	
I interface	64k, 128 kbps	1,700	Metal	1,700	1,700	Metal	1,700	1,700	1,700	1,700	1,700
Optical	7,500	Optical	7,000								
192 kbps - 1.5 Mbps	19,000	19,000		19,000	19,000		19,000	19,000	19,000	19,000	
3 Mbps - 6 Mbps	21,000	21,000		21,000	21,000		21,000	21,000	21,000	21,000	
Y interface	64k, 128 kbps	7,000	7,000		7,000	7,000		5,000	6,000	5,000	—
192 kbps - 1.5 Mbps	26,000	26,000		26,000	26,000		26,000	21,000	25,000	—	
3 Mbps - 6 Mbps	28,000	28,000		28,000	28,000		28,000	23,000	28,000	—	

Note 1: "Metal" means wiring with metallic cable; "optical," wiring with fiber-optic cable.

Note 2: The table shows the charges when line-termination equipment (DSU) for a Y interface, or line-connection equipment (I interface) is leased from the communications company.

Note 3: Only leased Y-interface line-termination equipment can be used. However, the subscriber can purchase his own I-interface line-connection equipment, in which case there would be no monthly charge.

Note 4: CTC provides 128-kbps, 256-kbps, 512-kbps, 1-Mbps, 2-Mbps, and 4.5-Mbps Y-interface-compatible high-speed digital transmission services. The special charges for that line-termination equipment are ¥26,000 for 128-kbps, 256-kbps, 512-kbps, and 1-Mbps lines, and ¥28,000 for 2-Mbps and 4.5-Mbps lines.

Note 5: TTNet and CTC also offer 64-kbps and 128-kbps fiber-optic lines. All other TTNet and CTC services are with metallic wiring.

Note 6: CTNet does not provide Y-interface high-speed digital transmission service.

Note 7: "bps" is an abbreviation for bits per second.

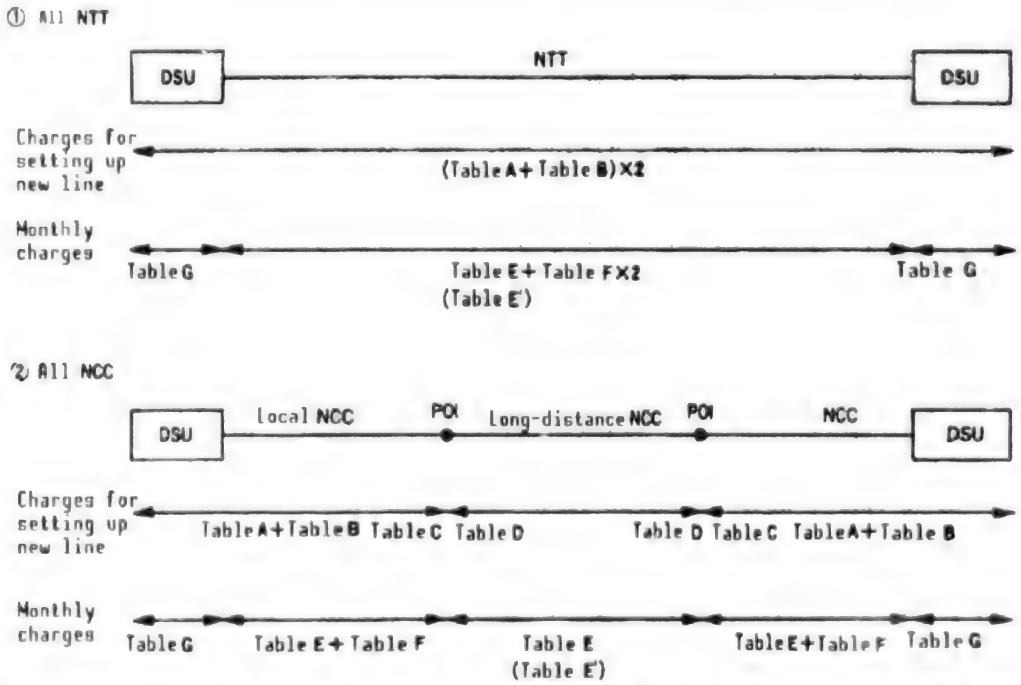


Figure A. Simulation of Charge Computations. Two typical cases are shown: 1) all-NTT service and 2) all-NCC service. The charges given in Tables A-G apply for each. See Figure 4 for a simulation of the case of a 1.5-Mbps line between Tokyo and Osaka. DSU stands for line-termination equipment.

Table I. Newly Added Distance Categories in NTT's High-Speed Digital Transmission Services. Eight new categories were added for a total of 20 distance categories.

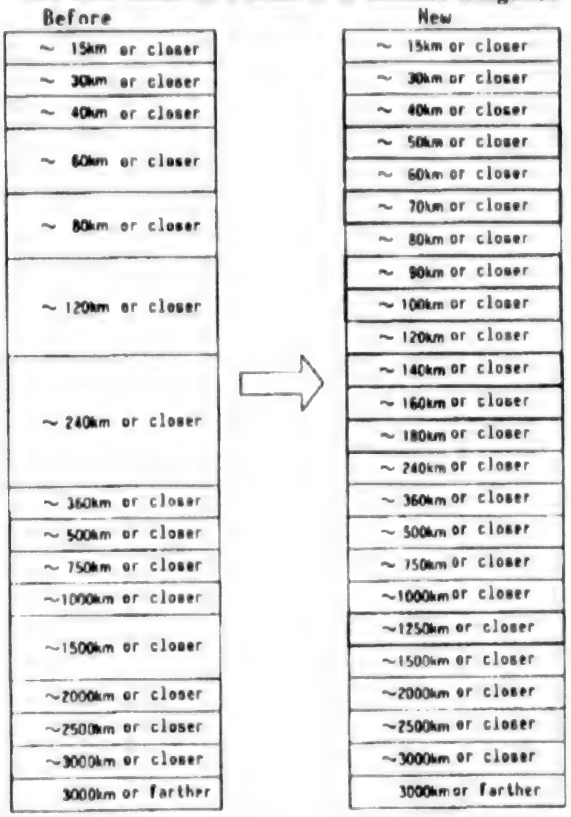


Table H. Points of Interconnection Between NTT and Long-Distance NCCs (as of 1 September 1993)

JT	Asahikawa, Kitami, Kushiro, Obihiro, Takigawa, Sapporo, Tomakomai, Hakodate, Aomori, Hirosaki, Hachinohe, Morioka, Ichinoseki, Sendai, Sagae, Akita, Yamagata, Yonezawa, Niigata, Nagaoka, Joetsu, Fukushima, Koriyama, Shirakawa, Utsunomiya, Oyama, Maebashi, Takasaki, Mito, Tsuchiura, Urawa, Yamaguchi, Kumagaya, Chiba, Funabashi, Ichikawa, Kashiwa, Tokyo-Shinjuku, Tachikawa, Hachioji, Yokohama, Kawasaki, Fujisawa, Kofu, Nagano, Matsumoto, Toyama, Takaoka, Kanazawa, Komatsu, Fukui, Numazu, Shizuoka, Hamamatsu, Toyohashi, Kariya, Ogaki, Nagoya, Ichinomiya, Gifu, Yokkaichi, Otsu, Kyoto, Osaka, Yao, Ibaraki, Yamatotakada, Wakayama, Kobe, Nishinomiya, Himeji, Okayama, Kurashiki, Fukuyama, Hiroshima, Kure, Matsuyama, Tokuyama, Yamaguchi, Tottori, Matsue, Takamatsu, Tokushima, Kochi, Marugame, Kita Kyushu, Fukuoka, Saga, Sasebo, Nagasaki, Nakatsu, Oita, Kumamoto, Yashiro, Miyazaki, Kagoshima, Shikaya (97 POIs in total)
DDI	Sapporo, Hakodate, Asahikawa, Tomakomai, Kitami, Kushiro, Obihiro, Aomori, Hachinohe, Ichinoseki, Morioka, Akita, Sendai, Yamagata, Sagae, Fukushima, Koriyama, Niigata, Nagaoka, Nagano, Suwa, Matsumoto, Maebashi, Ota, Utsunomiya, Mito, Tsuchiura, Tokyo, Tachikawa, Yokohama, Atsugi, Chiba, Kisarazu, Urawa, Kofu, Shizuoka, Numazu, Hamamatsu, Yokkaichi, Matsuzaka, Gifu, Nagoya, Ichinomiya, Okazaki, Kanazawa, Fukui, Toyama, Takaoka, Osaka, Ibaraki, Sakai, Wakayama, Nara, Otsu, Kyoto, Fukuchiyama, Kobe, Himeji, Okayama, Kurashiki, Fukuyama, Tottori, Matsue, Hiroshima, Iwakuni, Yamaguchi, Takamatsu, Tokushima, Matsuyama, Kochi, Kita Kyushu, Fukuoka, Nagasaki, Sasebo, Saga, Kumamoto, Yashiro, Oita, Nobeoka, Miyazaki, Kagoshima, Shikaya (82 POIs in total)
TWJ	Morioka, Sendai, Yamagata, Fukushima, Mito, Tsuchiura, Utsunomiya, Maebashi, Takazaki, Tokyo, Musashino-Mitaka, Tachikawa, Urawa, Kuki, Chiba, Kawasaki, Yokohama, Atsugi, Kofu, Nagano, Numazu, Shizuoka, Hamamatsu, Toyohashi, Toyoda, Kasugai, Nagoya, Ichinomiya, Gifu, Yokkaichi, Nagahama, Otsu, Kyoto, Ibaraki, Osaka, Sakai, Yamatotakada, Wakayama, Nishinomiya, Kobe, Himeji, Okayama, Kurashiki, Fukuyama, Higashi Hiroshima, Hiroshima, Iwakuni, Yamaguchi, Kita Kyushu, Fukuoka, Kumamoto (51 POIs in total)

Service item	64kbps								
Company / Distance	NTT	JT DDI TWJ	TT-Net	OMP	CTC	QT-Net	ST-Net	HOT-net	CT-Net
15km or less	42	14	38	36	34	34	39	33	34
30km or less	100		88	90	85	80	94	80	80
40km or less	158	75	148	155	149	145	161	140	142
45km or less	170	92						155	
50km or less			167	171	165	155	184		152
60km or less	180								
70km or less	190	105	180	184	175	170	203	170	167
80km or less	200								
90km or less	205	115							
100km or less	210		192	194	185	180	218	180	177
120km or less	215								
140km or less	218	145	211	210	205	190	232	200	191
150km or less	220								
160km or less						195	239		
180km or less	225								
210km or less	235		215	220	215	200	246	210	203
240km or less						205			
270km or less	290	200	255	260		230		255	230
300km or less						240			
330km or less						250			
360km or less						260			
500km or less	345	260				310			
750km or less	420	330							
1000km or less	475	385							
1000km or more	520	515							

Table E. Comparison of NTT's, Seven Local NCCs' and Three Long-Distance NCCs' Basic Monthly Charges for High-Speed Digital Transmission Services (Unit: ¥ 1,000)

<table>
<tr><td>Service item</td><td colspan="9">128kbps</td></tr>
<tr><td>Company
Distance</td><td>NTT</td><td>JT
DDI
TWJ</td><td>TT-
Net</td><td>OMP</td><td>CTC</td><td>QT-
Net</td><td>ST-
Net</td><td>HOT-
net</td><td>CT-
Net</td></tr>
<tr><td>15km or less</td><td>67</td><td rowspan="2">27</td><td>61</td><td>59</td><td>57</td><td>55</td><td>57</td><td>55</td><td>55</td></tr>
<tr><td>30km or less</td><td>165</td><td>146</td><td>151</td><td>145</td><td>130</td><td>142</td><td>135</td><td>130</td></tr>
<tr><td>40km or less</td><td>245</td><td>115</td><td rowspan="2">231</td><td rowspan="2">244</td><td rowspan="2">230</td><td rowspan="2">230</td><td rowspan="2">230</td><td>225</td><td rowspan="2">226</td></tr>
<tr><td>45km or less</td><td rowspan="2">270</td><td rowspan="3">150</td><td rowspan="3">260</td></tr>
<tr><td>50km or less</td><td rowspan="2">270</td><td rowspan="2">269</td><td rowspan="2">260</td><td rowspan="2">250</td><td rowspan="2">260</td><td rowspan="2">245</td></tr>
<tr><td>60km or less</td><td>293</td></tr>
<tr><td>70km or less</td><td>300</td><td rowspan="2">155</td><td rowspan="3">278</td><td rowspan="3">282</td><td rowspan="3">270</td><td rowspan="3">270</td><td rowspan="3">270</td><td rowspan="3">265</td><td rowspan="3">265</td></tr>
<tr><td>80km or less</td><td>305</td></tr>
<tr><td>90km or less</td><td>310</td><td rowspan="3">180</td></tr>
<tr><td>100km or less</td><td>320</td><td rowspan="2">298</td><td rowspan="2">305</td><td rowspan="2">295</td><td rowspan="2">285</td><td rowspan="2">295</td><td rowspan="2">290</td><td rowspan="2">280</td></tr>
<tr><td>120km or less</td><td>330</td></tr>
<tr><td>140km or less</td><td>335</td><td rowspan="5">225</td><td rowspan="5">330</td><td rowspan="5">330</td><td rowspan="5">325</td><td>310</td><td>315</td><td rowspan="5">315</td><td rowspan="5">314</td></tr>
<tr><td>150km or less</td><td rowspan="2">340</td></tr>
<tr><td>160km or less</td><td rowspan="2">320</td><td rowspan="2">325</td></tr>
<tr><td>180km or less</td><td>350</td></tr>
<tr><td>210km or less</td><td rowspan="2">365</td><td rowspan="3">335</td><td rowspan="3">345</td><td rowspan="8">335</td><td>330</td><td rowspan="8">335</td><td rowspan="3">325</td><td rowspan="3">333</td></tr>
<tr><td>240km or less</td><td>335</td></tr>
<tr><td>270km or less</td><td rowspan="4">445</td><td rowspan="4">305</td><td rowspan="7">395</td><td rowspan="7">410</td><td>360</td></tr>
<tr><td>300km or less</td><td>380</td></tr>
<tr><td>330km or less</td><td>390</td></tr>
<tr><td>360km or less</td><td>400</td></tr>
<tr><td>500km or less</td><td>530</td><td>390</td><td rowspan="4">480</td><td rowspan="7">395</td><td rowspan="7">360</td></tr>
<tr><td>750km or less</td><td>635</td><td>495</td></tr>
<tr><td>1000km or less</td><td>745</td><td>605</td></tr>
<tr><td>1000km or more</td><td>815</td><td>755</td></tr>
</table>

Continuation of Table E.

Service item	192kbps								
Company / Distance	NTT	JT DDI TWJ	TT-Net	OMP	CTC	QT-Net	ST-Net	HOT-net	CT-Net
15km or less	88	35	80	80	74	70	76	70	70
30km or less	215		189	200	189	170	184	175	170
40km or less	335	155	309	323	310	310	310	295	304
45km or less	365	195						335	
50km or less			353	362	345	330	345		324
60km or less	395								
70km or less	400	200	360	367	355	350	355	340	343
80km or less	405								
90km or less	410	220							
100km or less	420		376	387	370	370	372	360	363
120km or less	430								
140km or less	440	285	425	430	420	410	421	415	412
150km or less	450								
160km or less						420	433		
180km or less	460								
210km or less	485		430	440	435	430	445	425	433
240km or less						435			
270km or less	590	390	510	525		470		510	470
300km or less						490			
330km or less						510			
360km or less						530			
500km or less	705	500				630			
750km or less	830	620							
1000km or less	1000	780							
1000km or more	1100	980							

Continuation of Table E.

Service item	256kbps								
Company / Distance	NTT	JT DDI TWJ	TT-Net	OMP	CTC	QT-Net	ST-Net	HOT-net	CT-Net
15km or less	106	42	96	97	92	85	90	85	85
30km or less	260		229	243	225	210	215	210	210
40km or less	405	185	370	388	374	370	370	355	363
45km or less	440	240						410	
50km or less			430	441	425	390	410		383
60km or less	475								
70km or less	485	250	447	447	435	420	430	420	412
80km or less	495								
90km or less	505	280							
100km or less	515		470	471	465	445	450	450	437
120km or less	530								
140km or less	540	355	523	520	515	475	480	490	481
150km or less	550								
160km or less						490	500		
180km or less	565								
210km or less	595		530	535	535	505	530	510	513
240km or less						520			
270km or less	730	490	630	640		565		630	565
300km or less						590			
330km or less						610			
360km or less						630			
500km or less	865	615				750			
750km or less	1010	755							
1000km or less	1200	940							
1000km or more	1310	1090							

Continuation of Table E.

Service item	384kbps								
Company / Distance	NTT	JT DDI TWJ	TT-Net	OMP	CTC	QT-Net	ST-Net	HOT-net	CT-Net
15km or less	137	65	125	127	118	110	116	110	110
30km or less	345		304	321	300	275	293	285	275
40km or less	525	250	493	512	495	490	490	470	481
45km or less	565	310						530	
50km or less			555	571	550	520	553		510
60km or less	605								
70km or less	615	325	570	586	565	560	567	545	545
80km or less	625								
90km or less	635	355							
100km or less	645		600	615	595	590	595	575	575
120km or less	665								
140km or less	675	450	670	685	660	630	657	625	638
150km or less	690								
160km or less						650	675		
180km or less	700								
210km or less	735		675	695	685	670	693	650	678
240km or less						685			
270km or less	900	620	800	830		750		785	750
300km or less						780			
330km or less						810			
360km or less						840			
500km or less	1070	780				1000			
750km or less	1280	985							
1000km or less	1550	1220							
1000km or more	1690	1360							

Continuation of Table E.

Service item	512kbps								
Company / Distance	NTT	JT DDI TWJ	TT-Net	OMP	CTC	QT-Net	ST-Net	HOT-net	CT-Net
15km or less	164	70	150	153	142	130	135	130	130
30km or less	405		356	387	345	330	330	330	330
40km or less	620	250	580	604	585	580	580	550	569
45km or less	675	375						635	
50km or less			670	687	665	620	620		608
60km or less	725								
70km or less	740	390	695	702	680	670	670	650	657
80km or less	755								
90km or less	770	450							
100km or less	790		740	742	735	700	710	710	687
120km or less	820								
140km or less	835	565	820	825	815	770	775	770	780
150km or less	845								
160km or less						795	795		
180km or less	860								
210km or less	900		828	840	845	820	830	805	828
240km or less						835			
270km or less	1130	790	1000	1000		930		1000	930
300km or less						960			
330km or less						990			
360km or less						1030			
500km or less	1320	980				1220			
750km or less	1570	1230							
1000km or less	1910	1520							
1000km or more	2070	1590							

Continuation of Table E.

<table>
<tr><td>Service item</td><td colspan="9">768kbps</td></tr>
<tr><td>Company
Distance</td><td>NTT</td><td>JT
DDI
TWJ</td><td>TT-
Net</td><td>OMP</td><td>CTC</td><td>QT-
Net</td><td>ST-
Net</td><td>HOT-
net</td><td>CT-
Net</td></tr>
<tr><td>15km or less</td><td>215</td><td rowspan="2">80</td><td>195</td><td>195</td><td>186</td><td>170</td><td>180</td><td>174</td><td>170</td></tr>
<tr><td>30km or less</td><td>495</td><td>455</td><td>440</td><td>425</td><td>430</td><td>425</td><td>425</td><td>430</td></tr>
<tr><td>40km or less</td><td>785</td><td>380</td><td rowspan="2">762</td><td rowspan="2">792</td><td rowspan="2">765</td><td rowspan="2">760</td><td rowspan="2">795</td><td>725</td><td rowspan="2">746</td></tr>
<tr><td>45km or less</td><td rowspan="2">855</td><td rowspan="3">480</td><td rowspan="3">815</td></tr>
<tr><td>50km or less</td><td rowspan="2">860</td><td rowspan="2">870</td><td rowspan="2">830</td><td rowspan="2">810</td><td rowspan="2">815</td><td rowspan="2">795</td></tr>
<tr><td>60km or less</td><td>920</td></tr>
<tr><td>70km or less</td><td>940</td><td rowspan="2">515</td><td rowspan="3">910</td><td rowspan="3">925</td><td rowspan="3">890</td><td rowspan="3">880</td><td rowspan="3">895</td><td rowspan="3">860</td><td rowspan="3">863</td></tr>
<tr><td>80km or less</td><td>955</td></tr>
<tr><td>90km or less</td><td>975</td><td rowspan="3">580</td></tr>
<tr><td>100km or less</td><td>1000</td><td rowspan="2">970</td><td rowspan="2">980</td><td rowspan="2">935</td><td rowspan="2">920</td><td rowspan="2">915</td><td rowspan="2">910</td><td rowspan="2">903</td></tr>
<tr><td>120km or less</td><td>1040</td></tr>
<tr><td>140km or less</td><td>1060</td><td rowspan="5">730</td><td rowspan="5">1070</td><td rowspan="5">1055</td><td rowspan="5">1065</td><td rowspan="2">1010</td><td rowspan="2">1060</td><td rowspan="5">1035</td><td rowspan="5">1020</td></tr>
<tr><td>150km or less</td><td rowspan="3">1090</td></tr>
<tr><td>160km or less</td><td rowspan="3">1040</td><td rowspan="3">1090</td></tr>
<tr><td>180km or less</td><td>1110</td></tr>
<tr><td>210km or less</td><td rowspan="3">1180</td><td rowspan="3">1080</td><td rowspan="3">1075</td><td rowspan="12">1095</td><td>1070</td><td rowspan="12">1110</td><td rowspan="3">1055</td><td rowspan="3">1080</td></tr>
<tr><td>240km or less</td><td>1090</td></tr>
<tr><td>270km or less</td><td rowspan="4">1450</td><td rowspan="4">1000</td><td rowspan="11">1290</td><td rowspan="11">1255</td><td>1200</td><td rowspan="11">1290</td><td rowspan="11">1200</td></tr>
<tr><td>300km or less</td><td>1250</td></tr>
<tr><td>330km or less</td><td>1300</td></tr>
<tr><td>360km or less</td><td>1350</td></tr>
<tr><td>500km or less</td><td>1710</td><td>1270</td><td rowspan="4">1590</td></tr>
<tr><td>750km or less</td><td>2050</td><td>1620</td></tr>
<tr><td>1000km or less</td><td>2470</td><td>1950</td></tr>
<tr><td>1000km or more</td><td>2690</td><td>1980</td></tr>
</table>

Continuation of Table E.

Service item	1 Mbps								
Company / Distance	NTT	JT DDI TWJ	TT-Net	OMP	CTC	QT-Net	ST-Net	HOT-net	CT-Net
15km or less	280	110	257	253	250	230	240	225	230
30km or less	640		606	572	565	560	560	560	560
40km or less	1020	495	990	1029	1000	960	990	945	942
45km or less	1110	640						1090	
50km or less			1140	1131	1135	1060	1090		1040
60km or less	1200								
70km or less	1220	765	1190	1202	1170	1160	1160	1125	1138
80km or less	1240								
90km or less	1270	675	1270	1274	1255	1210	1220	1215	1187
100km or less	1300								
120km or less	1350								
140km or less	1380	950	1390	1370	1380	1270	1300	1350	1315
150km or less	1410								
160km or less						1340	1370		
180km or less	1440								
210km or less	1530		1410	1395	1430	1380	1430	1370	1400
240km or less						1420			
270km or less	1870	1320	1660	1630		1570		1670	1570
300km or less						1640			
330km or less						1720			
360km or less						1770			
500km or less	2220	1670				2100			
750km or less	2660	2100							
1000km or less	3210	2560							
1000km or more	3490	2680							

Continuation of Table E.

<table>
<tr><td>Service item</td><td colspan="8">1.5Mbps</td></tr>
<tr><td>Company
Distance</td><td>NTT</td><td>JT
DDI
TWJ</td><td>TT-
Net</td><td>OMP</td><td>CTC</td><td>QT-
Net</td><td>ST-
Net</td><td>HOT-
net</td><td>CT-
Net</td></tr>
<tr><td>15km or less</td><td>337</td><td rowspan="2">135</td><td>310</td><td>300</td><td>300</td><td>270</td><td>285</td><td>270</td><td>270</td></tr>
<tr><td>30km or less</td><td>775</td><td>720</td><td>655</td><td>685</td><td>680</td><td>670</td><td>670</td><td>680</td></tr>
<tr><td>40km or less</td><td>1190</td><td>550</td><td rowspan="2">1160</td><td rowspan="2">1198</td><td rowspan="2">1160</td><td rowspan="2">1160</td><td rowspan="2">1210</td><td>1090</td><td rowspan="2">1138</td></tr>
<tr><td>45km or less</td><td rowspan="2">1300</td><td rowspan="3">755</td><td rowspan="3">1240</td></tr>
<tr><td>50km or less</td><td rowspan="2">1305</td><td rowspan="2">1350</td><td rowspan="2">1325</td><td rowspan="2">1280</td><td rowspan="2">1260</td><td rowspan="2">1256</td></tr>
<tr><td>60km or less</td><td>1400</td></tr>
<tr><td>70km or less</td><td>1440</td><td rowspan="2">780</td><td rowspan="3">1390</td><td rowspan="3">1423</td><td rowspan="3">1375</td><td rowspan="3">1400</td><td rowspan="3">1390</td><td rowspan="3">1320</td><td rowspan="3">1373</td></tr>
<tr><td>80km or less</td><td>1470</td></tr>
<tr><td>90km or less</td><td>1500</td><td rowspan="3">910</td></tr>
<tr><td>100km or less</td><td>1530</td><td rowspan="2">1500</td><td rowspan="2">1500</td><td rowspan="2">1495</td><td rowspan="2">1460</td><td rowspan="2">1440</td><td rowspan="2">1415</td><td rowspan="2">1432</td></tr>
<tr><td>120km or less</td><td>1590</td></tr>
<tr><td>140km or less</td><td>1630</td><td rowspan="5">1140</td><td rowspan="5">1660</td><td rowspan="5">1630</td><td rowspan="5">1665</td><td>1540</td><td>1660</td><td rowspan="5">1605</td><td rowspan="5">1589</td></tr>
<tr><td>150km or less</td><td rowspan="2">1670</td><td rowspan="3">1620</td><td rowspan="3">1710</td></tr>
<tr><td>160km or less</td></tr>
<tr><td>180km or less</td><td>1710</td></tr>
<tr><td>210km or less</td><td rowspan="2">1830</td><td rowspan="2">1685</td><td rowspan="2">1670</td><td rowspan="11">1720</td><td>1670</td><td rowspan="11">1760</td><td rowspan="2">1625</td><td rowspan="2">1695</td></tr>
<tr><td>240km or less</td><td>1720</td></tr>
<tr><td>270km or less</td><td rowspan="4">2250</td><td rowspan="4">1580</td><td rowspan="8">2000</td><td rowspan="8">1950</td><td>1900</td><td rowspan="8">2000</td><td rowspan="8">1900</td></tr>
<tr><td>300km or less</td><td>1990</td></tr>
<tr><td>330km or less</td><td>2080</td></tr>
<tr><td>360km or less</td><td>2140</td></tr>
<tr><td>500km or less</td><td>2700</td><td>2040</td><td rowspan="4">2550</td></tr>
<tr><td>750km or less</td><td>3240</td><td>2580</td></tr>
<tr><td>1000km or less</td><td>3860</td><td>3090</td></tr>
<tr><td>1000km or more</td><td>4210</td><td>3170</td></tr>
</table>

Continuation of Table E.

Service item	2 Mbps
Company / Distance	CTC
15km or less	385
30km or less	865
40km or less	1530
45km or less	
50km or less	1700
60km or less	
70km or less	1825
80km or less	
90km or less	
100km or less	1900
120km or less	
140km or less	2210
150km or less	
160km or less	
180km or less	
210km or less	2270
240km or less	
270km or less	
300km or less	
330km or less	
360km or less	
500km or less	
750km or less	
1000km or less	
1000km or more	

Continuation of Table E.

Service item	3 Mbps								
Company / Distance	NTT	JT DDI TWJ	TT-Net	OMP	CTC	QT-Net	ST-Net	HOT-net	CT-Net
15km or less	532	195	495	490	470	440	450	430	440
30km or less	1220		1130	1130	1055	1080	1060	1050	1080
40km or less	1940	945	1885	1967	1900	1900	1980	1805	1864
45km or less	2110	1210						2015	
50km or less			2140	2150	2075	2040	2030		2001
60km or less	2270								
70km or less	2310	1270	2230	2285	2215	2210	2220	2125	2168
80km or less	2350								
90km or less	2400	1430							
100km or less	2450		2390	2370	2320	2340	2280	2240	2296
120km or less	2550								
140km or less	2610	1850	2680	2590	2685	2460	2650	2575	2541
150km or less	2680								
160km or less						2590	2720		
180km or less	2740								
210km or less	2930		2710	2640	2765	2680	2800	2605	2720
240km or less						2760			
270km or less	3630	2580	3230	3160		3030		3225	3030
300km or less						3170			
330km or less						3310			
360km or less						3450			
500km or less	4190	3140				3950			
750km or less	5090	4100							
1000km or less	6050	4850							
1000km or more	6610	5040							

Continuation of Table E.

Service item	4.5Mbps								
Company / Distance	NTT	JT DDI TWJ	TT-Net	OMP	CTC	QT-Net	ST-Net	HOT-net	CT-Net
15km or less	690	280	635	635	610	570	600	555	570
30km or less	1580		1495	1465	1395	1400	1400	1370	1400
40km or less	2520	1230	2450	2551	2470	2500	2500	2340	2453
45km or less	2740	1580						2690	
50km or less			2820	2789	2680	2670	2700		2619
60km or less	2950								
70km or less	3010	1670	2910	2964	2895	2930	2900	2780	2874
80km or less	3070								
90km or less	3140	1930							
100km or less	3200		3150	3074	3035	3060	3050	3010	3002
120km or less	3330								
140km or less	3410	2370	3450	3360	3425	3280	3250	3320	3375
150km or less	3480								
160km or less						3440	3400		
180km or less	3560								
210km or less	3780		3490	3425	3560	3550	3500	3350	3605
240km or less						3660			
270km or less	4640	3280	4130	4100		3970		4100	3970
300km or less						4150			
330km or less						4330			
360km or less						4520			
500km or less	5490	4140				5290			
750km or less	6570	5290							
1000km or less	7910	6390							
1000km or more	8610	6620							

Continuation of Table E.

Service item	6 Mbps								
Company / Distance	NTT	JT DDI TWJ	TT-Net	OMP	CTC	QT-Net	ST-Net	HOT-net	CT-Net
15km or less	830	320	770	790	735	680	705	665	680
30km or less	1900		1760	1750	1675	1690	1660	1630	1690
40km or less	3060	1510	2980	3100	3005	3000	3120	2840	2943
45km or less	3320	1920						3185	
50km or less			3390	3400	3255	3200	3200		3139
60km or less	3580								
70km or less	3640	2010	3500	3593	3480	3510	3540	3340	3443
80km or less	3700								
90km or less	3780	2280							
100km or less	3860		3760	3750	3655	3670	3630	3555	3597
120km or less	4010								
140km or less	4100	2850	4150	4080	4120	3930	4180	4000	4048
150km or less	4190								
160km or less						4130	4290		
180km or less	4280								
210km or less	4550		4210	4125	4280	4260	4400	4040	4255
240km or less						4400			
270km or less	5720	4080	5100	5020		4760		5080	4760
300km or less						4980			
330km or less						5200			
360km or less						5420			
500km or less	6660	5030				6350			
750km or less	8010	6480							
1000km or less	9390	7580							
1000km or more	10300	7960							

Continuation of Table E.

- There are 12 types of service for the international standard I interface: 64-kbps, 128-kbps, 192-kbps, 256-kbps, 384-kbps, 512-kbps, 768-kbps, 1-Mbps, 1.5-Mbps, 3-Mbps, 4.5-Mbps, and 6-Mbps services. There are seven types of service for NTT's own Y interface: 64-kbps, 192-kbps, 384-kbps, 768-kbps, 1.5-Mbps, 3-Mbps, and 6-Mbps services. CTC provides 12 types of service, ranging from 64 kbps to 6 Mbps, for the Y interface, too. There is also an "intermediate-speed" 2-Mbps service.
- Because seven local NCCs—TTNet, OMP, CTC, QTNet, STNet, HOTnet, and CTNet—directly connect subscribers, NTT's subscriber-to-POI and POI-to-subscriber lines are not needed.
- As for the longest distance categories of the local NCCs, TTNet, OMP, HOTnet, and CTNet showed charges for over 240 km; CTC and STNet, for over 180 km; and QTNet, for over 360km.

Table J. Locations of Points of Interconnection Between Long-Distance NCCs and Local NCCs (as of 1 February 1994)

JT	DDI	TWJ	
TTNet	Tokyo (Tokyo Metropolis, Taito-ku), Tachikawa (Tokyo Metropolis, Akishima City)	Tokyo (Tokyo Metropolis, Sendai-ku, Uchiyuki-cho), Tama (Tokyo Metropolis, Tama City)	Tokyo (Tokyo Metropolis, Sendai-ku, Hirakawa-cho), Yokohama (Yokohama City, Kanagawa-ku)
OMP	Osaka (Osaka City, Nishisadakawa-ku), Kyoto (Kyoto City, Minami-ku), Kobe (Kobe City, Chuo-ku)	Osaka (Osaka City, Kita-ku), Kyoto (Kyoto City, Fushimi-ku), Kobe (Kobe City, Chuo-ku)	Osaka (Osaka City, Nishisadakawa-ku), Kyoto (Kyoto City, Fushimi-ku), Kobe (Kobe City, Chuo-ku)
CTC	Nagoya (Nagoya City, Nakagawa-ku), Yokkaichi (Mie Prefecture, Yokkaichi City), Shizuoka (Shizuoka Prefecture, Shizuoka City)	Nagoya (Nagoya City, Nakamura-ku) Nagoya (Aichi Prefecture, Kasugai City), Toyoda (Aichi Prefecture, Toyoda City)	
QTNet	Shizuoka (Shizuoka City, Hakata-ku)	Shizuoka (Shizuoka City, Chuo-ku)	Shizuoka (Shizuoka City, Chuo-ku)
STNet	Takamatsu (Takamatsu City, Fujitsuka-ku), Matsuyama (Matsuyama City, Sanban-cho)	Takamatsu (Takamatsu City Kasuga-cho), Matsuyama (Aichi Prefecture, Iyo-gun, Tobe-cho)	—
HOTnet	Sapporo (Sapporo City, Chuo-ku)	Sapporo (Sapporo City, Nishi-ku)	—
CTNet[Note 1]	Hiroshima (Hiroshima City), Okayama (Okayama City)	Hiroshima (Hiroshima City)	Hiroshima (Hiroshima City), Okayama (Okayama City)

Note 1: In the case of CTNet, the only interconnecting service is an I-interface high-speed digital transmission service.

Table K. NTT's Charges for Dedicated Line Engineering Work (Unit: ¥)

	Category	Fee
Basic engineering fee	Basic fee (for up to ¥ 29,000, the fee for each job)	4,500
Additional fees (when the total engineering fees exceed ¥ 29,000, this charge is added for every ¥ 29,000)	3,500	
Line connection, etc., only (for each job)	1,000	
Fees for line connection work	For each line brought in	1,000
Fee for indoor wiring work	When existing wire is not used	
Wiring other than cable wiring (for each line)	3,800	
Cable wiring (for each line)	8,000	
When existing wire is used	Wiring other than cable wiring (for each line)	1,200
Cable wiring (for each line)	3,900	
Fees for equipment engineering work	Line connection work	Real costs
Terminal control equipment (per device, pertains to image transfer services)	24,000	
Partial conversion of in-house equipment	Real costs	
Fees for engineering work for temporary suspension of service or to discontinue line use	Basic engineering fees (for each job)	1,000
Fees for line connection work (for each incoming line)	1,000	

Table L. Three Long-Distance NCCs' Monthly Charges for Private Wide-Band Wireless Services

Communications company	JT	DDI	TWJ
Name	Direct Access Service	DTS Service	TDA Service
Special terminal line charge[Note]			
64 kbps	—	93	70
192 kbps	—	104	110
384 kbps	119	116	120
768 kbps	162	162	160
1.5 Mbps	253	255	255
3 Mbps	407	405	405
6 Mbps	635	637	635
Special line-termination equipment charges			
64 kbps	—	16	16
192 kbps, 384 kbps, 768 kbps, 1.5 Mbps	21	21	21
3 Mbps, 6 Mbps	22	22	22

Note 1: The special terminal line charge is applied for each line. Wide-band wireless lines are only offered with Y-interface service.

Table M. NTT's, CTC's, and Three Long-Distance NCCs' Discount Rates for Heavy-Volume Dedicated-Line Usage

Total monthly line use chargesommunications company	NTT	JT, DDI, TWJ	CTC
Portion over ¥2 million and under ¥5 million	—	2%	2%
Portion over ¥5 million and under ¥10 million	3%	3%	3%
Portion over ¥10 million and under ¥30 million	4%	4%	4%
Portion over ¥30 million and under ¥50 million	5%	5%	
Portion over ¥50 million and under ¥100 million	6%	6%	
Portion over ¥100 million	7%	7%	

Note 1: NTT and CTC discount heavy-volume usage only for high-speed digital transmission service. Note 2: JT, DDI, and TWJ discount heavy-volume usage for both regular private service and high-speed digital transmission service.

Table N. Discounts Offered by NTT, Long-Distance NCCs, TTNet, and OMP for Long-Term Continued Usage

	NTT	Long-distance NCCs, OMP	TTNet
3-year contract	5%	5%	3%
6-year contract	11%	—	—

Table O. OMP's Multiple-Line Discount Rates

Number of lines to which discount applies	Discount rate
For each of up to 5-10 lines	3%
For each of up to 11-20 lines	4%
For each of up to 21-30 lines	5%
For each of up to 31-50 lines	6%
For each line over 50 lines	7%

Note 1: The discounts are limited to subscribers who applied for five or more high-speed digital transmission lines with the same application and under the same name.

Note 2: The basic monthly line charges for services "15km or closer" are each multiplied by the discount rate. The lines subject to discounts will be in the order from the lowest-speed lines leased by the subscriber. The contract period is three years.

Table P. Range of Basic Monthly Charge Reductions when Multiplexed Access Service is Used (Unit: ¥)

Communications company	NTT, OMP, CTC	TTNet	QTNet, STNet, HOTnet	CTNet
64 kbps, 128 kbps	2,430	2,435	2,400	2,000
Other speeds[Note 2]	18,000	18,000	18,000	15,000

Note 1: When multiplexed access service is used, the basic monthly charges are reduced for each line from the second line. When there are both 128-kbps or slower line(s) and 192-kbps or faster line(s), the reduction is for the 192-kbps or faster line(s).

Note 2: Concretely, for the following 10 services: 192-kbps, 256-bps, 384-kbps, 512-kbps, 768-kbps, 1-Mbps, 1.5-Mbps, 3-Mbps, 4.5-Mbps, and 6-Mbps services.

Note 3: "bps" is an abbreviation for bits per second.

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